DOCUMENT RESUME

ED 309 270 CE 052 892

TITLE	Training Implications of Technological Change in Manufacturing in New Industrial Countries: The Case of Ireland. Training Policies Discussion Paper No. 14.
INSTITUTION	International Labour Office, Geneva (Switzerland).
REPORT NO	ISBN-92-2-105646-5
PUB DATE	Jul 86
NOTE	78p.; Paper prepared by AnCO (Irish Industrial Training Authority).
AVAILABLE FROM	ILO Publications, International Labour Office, CH-1211, Geneva 22, Switzerland.
PUB TYPE	Reports - Research/Technical (143)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Adult Education; Foreign Countries; *Innovation; *Manufacturing; Manufacturing Industry; Personnel Policy; Postsecondary Education; Public Policy; Research and Development; *Skill Development; *Technological Advancement; *Technology Transfer
IDENTIFIERS	*Ireland

ABSTRACT

This report on Ireland is one in a series of studies for a research project designed to identify training and education policies pursued by governments and individual firms that have contributed to innovation, technological adaptation, and skill development in manufacturing. Part 1 describes Ireland's economic, social, and educational structure and provides information on Irish industrial and technology policies, including government training policy. A 29-item bibliography is provided. Part 2 presents details of six case studies of firms that have introduced technological innovations that could be widely applied and diffused elsewhere. These include such innovations as computer-aided design, computer-aided manufacturing, robotic welding, computerized numerical control equipment, and the introduction of microelectronics to factory automation. Each case study is divided into these areas: company profile, innovation, support for innovation, manpower use, profile, innovation, support for innovation, manpower use, training, and testing of 13 hypotheses. (YLB)

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TRAINING POLICIES

Discussion Paper No. 14

TRAINING IMPLICATIONS OF TECHNOLOGICAL CHANGE IN MANUFACTURING IN NEW INDUSTRIAL COUNTRIES: THE CASE OF IRELAND

by

AnCO
(Irish Industrial Training Authority)

Note: Discussion papers are preliminary material circulated to stimulate critical discussion and critical comment.

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July 1986

International Labour Office
Geneva

CE052-892

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ISBN 92-2-105646-5

First published 1986

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Printed by the International Labour Office, Geneva, Switzerland

PREFACE

This report on Ireland is part of an International Labour Office study entitled "Training Implications of Technological Change in Manufacturing in New Industrial Countries". It was undertaken by AnCO, the Irish Industrial Training Authority which plays a major role in implementing Irish Government training policy and in encouraging and assisting firms by providing training. The report is one of several similar ILO-commissioned studies made in such countries as Brazil, Hong Kong, India, Korea, Venezuela and Yugoslavia.

The overall ILO objective is to identify those policies, in particular training and education policies, pursued by governments and individual firms, which have contributed to innovation, technological adaptation and skill development in manufacturing.

Many new industrial countries (NICs) are pursuing policies to develop high technology and skill intensive industries. A broad array of policies have been implemented with varying success.

These include traditional macro-economic policies, including fiscal and tariff measures, and specific technology policies such as product development grants to enterprises, support schemes for licensing and technology agreements with foreign firms and governments. Policies and programmes to educate and train needed manpower are regarded as extremely essential. An indispensable condition for successful innovative activity and product and process adaptation is an adequate supply of and effective use of manpower.

Some countries and some enterprises have been more successful than others in changing and adapting their industrial sectors, product lines and manufacturing processes. In this study on Ireland, we have examined firms which have introduced technological innovations which could be widely applied and diffused elsewhere. These include such innovations as Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), Robotic Welding, Computerized Numerical Control (CNC) equipment and the introduction of microelectronics to factory automation.

We have examined the impact these innovations have had on the skill levels and qualifications of company personnel and on any resulting reorganisation of work. The rationale behind innovation and the support given to it are also examined, as are the factors which influenced the changes in the company. Findings from these case studies are used to test a set of hypotheses about the policies involved, particularly the training policies and programmes.

This study includes a description of Ireland's economic, social and educational structure as well as information on Irish industrial and technology policies including Government training policy.

Methodology and Presentation

The economic profile of Ireland and its training policy was compiled from many reports and publications listed in an attached bibliography. Interviews were also conducted with personnel from State bodies.

The six companies studied were chosen from an initial list of more than 20 proposed by AnCO's Training Advisory Service Staff (Engineering Designation). The final six were selected for the quality of their innovative activities, as well as to provide examples of changes in small and large companies, in Irish-owned as compared to multinational companies, and because of the geographical dispersion of the plants. Each company was visited by Research and Planning researchers and by Training Advisory Staff, and in-depth interviews were conducted with management and staff. A questionnaire was used to record the findings.

This report is in two main sections. Part 1 deals with Ireland's economic profile and with Government training policy. Section 2 presents details of these six case studies:

(1) Inland Kollmorgen Ltd., an American firm in Ennis, County Clare. Employs 160 people and manufacturers precision motion control components. We examined the company's objective to become a centre of technical excellence in precision motion control.

(2) State Engineerings Company Ltd., an Irish-owned company in Sligo, West Ireland. Employs 32 people and manufactures contract mould tools. We examined the introduction of a CAD/CAM system.

(3) Ardmore Engineering Ltd., an Irish-owned company in Dublin. Employs 26 people and mainly makes precision engineering products. We examined the introduction of CNC equipment.

(4) Crown Control Ltd., an American company in Galway. Employs around 240 people and manufactures pallet trucks. We examined the introduction of two robotic welding stations.

(5) Norco Ltd., is a joint Irish/American-owned company in Waterford. Employs about 50 people and manufactures high precision engineering products. We examined the introduction of CNC equipment.

(6) Braun Ltd., is a German-owned company in Carlow. Employs more than 1,000 people. It makes hair dryers, shavers, etc. We examined the use of mechanical/electronic/pneumatic equipment.

TABLE OF CONTENTS

		Page
PREFACE		i
PART 1:	IRELAND	
	Economy and Training	1
	Industrial and Technology Policies	3
	Economic, Social, Educational and Cultural Environment	6
	Government Training Policy and Objectives	9
	Relationship between Industry/ Technology Policy and Education/ Training Policy	10
	Planning of Training	12
	Structure and Performance of Training Systems	15
	Enrolment Policy	19
	Financing and Incentives for Training	20
	Bibliography	23
PART 2:	CASE STUDIES	
	Explanatory Note	25
	Inland Kollmorgan Ltd.	26
	Stet Engineering Ltd.	32
	Ardmore Engineering Ltd.	38
	Crown Automation (Ireland) Ltd.	41
	Norco Ltd.	49
	Braun (Ireland) Ltd.	56

TRAINING IMPLICATIONS OF TECHNOLOGICAL CHANGE IN MANUFACTURING IN NEW INDUSTRIAL COUNTRIES THE IRELAND CASE

PART 1

ECONOMY AND TRAINING

The modern Irish state was founded in 1922. At that time the industrial sector was made up of a small number of traditional manufacturers producing almost exclusively for the home market. Half the country's labour force was employed in subsistence agriculture. Protectionist measures were introduced in the 1930s to help indigenous industry, but economic depression, followed by war in Europe, resulted in Ireland's economic and social structure remaining relatively unaltered until well into the 1950s. There was little opportunity to expand employment.

Ireland's economic breakthrough had its origins in the late 1950s when it was decided to try to attract foreign manufacturers to set up in Ireland. The Government's Programme for Economic Expansion in 1958 offered generous aid and incentives to new industry. Capital grants were introduced to assist in setting up new export-oriented industries and tax concessions on profits from exports were allowed. As a result, the 1960s were a decade of growth, employment increased and the decline in population since 1922, mainly due to emigration, was halted. The growth of national output exceeded an average of 4% a year, exports increased as did industrial output, and this led to expanding private investment. Inflation was held at moderate levels, there were no major balance of payment problems, foreign investment provided a steady net capital inflow, and tourism increased.

To respond to growing manpower and skill needs, AnCO, the Industrial Training Authority, was set up in 1967 to provide training for industry.

Industrial growth continued into the early 1970s but by the middle of the decade inflation had begun to rise and there was a downturn in foreign investment due to the worldwide recession. Tourism decreased due to the conflict in Northern Ireland.

which followed and the later depression in the early 1980s which resulted in rising unemployment, Ireland's industrial sector has nevertheless continued to grow at an impressive rate. Between 1973 and 1983, industrial production increased by an average of 3.3% annually. This was well in excess of the EEC average and that of the United States[22]. The impact of new overseas investment in growth sectors of the Irish economy is shown by the expansion of industrial exports which, in 1984 alone, grew by 19% -- the highest rate in Europe. Between 1980 and 1985 there were rapid increases in the chemicals/pharmaceuticals and the electronics/information technology sectors. Electronics output alone increased by 40% during 1984.

Manpower and Population Trends in the 1970s and 1980s

From the early 1970s, the Irish labour force expanded rapidly (approximately 18,000 persons per annum) for numerous reasons. Emigration of youth diminished significantly and there was a return to Ireland of former emigrants with their families. Female participation in the workforce emerged as a factor when the ban was removed on married women in public service and other industries. There was a population increase of 15.6% between 1971 and 1981 -- 1.5% a year and four times the EEC average.Some 48% of Ireland's population is now under the age of 25, compared with a European average of 36%. Changes in residence patterns also have occurred. In 1951, 57% of the population lived in rural areas and 43% in towns. By 1981 this had changed to 56% in towns over 1,500 people and 44% in rural areas.

Unemployment has become once again Ireland's most serious social and economic problem. The number of persons out of work has risen from 65,000 in the early 1970s to 235,000 in September 1985. The rate of increase is the highest in the European Community. There has been continuous population growth since 1961 and all available projections indicate that over the next few years the number of new jobs will not be sufficient to absorb this natural increase in the labour force. This was acknowledged by the Government in its National Plan published in 1984 [9]. Taking the most optimistic employment forecasts and allowing for lower labour force growth, only a small reduction in unemployment can be foreseen by the early 1990s. If full employment is to be achieved in the last decade of the century, employment will have to grow at levels well above current forecasts.

At the same time, there have been substantial changes in the structure of employment in recent decades. In 1962, services employed 39.5% of the workforce, agriculture 37% and industry 23.5%. Twenty years later, in 1982, services were employing 52.2% of the workforce, agriculture had dropped to 17.1% and industry had risen to 30.7%.

The economy in the 1970s and 1980s

A significant factor in Ireland's recent economic history was the accumulation of a considerable foreign debt between 1973 and 1981,

run up in an effort to minimise the effect of world recession and to stimulate economic growth. The problems of servicing this growing debt have been made worse by difficulties in reducing public sector borrowing and by inflation and high international interest rates.

In an effort to correct the situation, constraints were imposed on the economy in 1981. Real GNP fell by 1.3% in 1982 and 0.7% in 1983. High taxation levels, reductions in public spending and a tightening of monetary policy were used to reverse the trends of the previous years and real GNP grow by 2% in 1984 while agricultural and industrial output rose markedly. Despite these improvements, unemployment continued to rise, although more slowly than before. Inflation, which had been 17% in 1982, was successfully brought down to 10.4% in 1983 and 5% in 1985.

In 1984, the Government published a White Paper on Industrial Policy [23] and a three-year economic and social plan called "Building on Reality" [9]. The industrial policy is discussed in more detail in the next part. The economic plan set out to "chart the way in which economic and social policy will develop over the next three years". It acknowledged that the Irish economy is vulnerable to international economic events. Its projections were based on such assumptions as a continued growth in world trade (which should result in more Irish exports), stable international exchange rates and consumer prices, and falling interest rates. The plan proposed to reduce public sector borrowing and maintain unchanged the ratio of tax revenue to GNP. To generate more employment, the Government proposed to reduce industrial production costs and increase competitiveness and industrial output.

INDUSTRIAL AND TECHNOLOGY POLICIES

Industrial policy

The Government White Paper on Industrial Policy [23] in 1984 came at the end of four years of intense policy discussion. Its objectives were to double manufacturing output over the following 10 years, maximise the "value added" from industry and international services, and retain within Ireland the wealth created.

The White Paper was intended to provide new impetus to industrial development because of the rundown in traditional industries and the fact that fewer new jobs had been created than had been lost. The White Paper put its finger on weaknesses in Irish industry: poor management, low levels of research and development, an inadequate financial base, lack of attention to exports and failure to achieve significant linkage with foreign industry located in the country.

The White Paper said it did not expect industry to grow rapidly enough to absorb the likely increase of 17,000 persons a year in the labour force. Despite the difficulty in making forecasts, it believed

manufacturing output could be doubled over 10 years and this could lead to an increase of 3,000-6,000 jobs a year in manufacturing. It felt that the country's ability to create jobs could be greatly improved if it could respond quicker than its competitors to new markets and new technology.

The Government said that its own role in such industrial development was to "provide grants and tax incentives (IR £750 million in 1983) ... a good infrastructure ... a favourable economic and fiscal environment and to ... encourage viable job-creating projects in the commercial state sector."

To achieve its objectives, the Government said it intended that:

(i) incentive and advice would be applied selectively, concentrating on internationally-traded manufacturing and service industries and particularly on those which were Irish-owned;
(ii) there would be a shift in State resources from fixed asset investment to acquisition of technology and in marketing development;
(iii) priority would be given to attracting overseas projects to Ireland;
(iv) a risk-capital market for investment in industry would be created;
(v) the business environment would be improved to increase the competitiveness and profitability of industry; and
(vi) effective educational, training and worker mobility measures would be promoted.

The Government took steps to meet the complaints of industrialists and managers that confusion was caused by the large number of State agencies offering advice and assistance. To simplify procedures, the Industrial Development Authority (IDA) was given responsibility for co-ordinating advice, offering assistance and providing training to small industry through its regional offices.

The White Paper also proposed other measures to co-ordinate activity. These included:

(i) Building in Cork an Enterprise Centre similar to that in Dublin which would offer small infrastructure services, AnCO training and management advice under one roof; and
(ii) AnCO to offer comprehensive industrial training to small firms, as well as marketing and product development packages using open-learning and computer-based training techniques.

Efforts were to be made to encourage managers and workers who had been declared redundant to start up their own businesses, using their often substantial redundancy payments. State agencies were instructed to give every assistance to redundant workers to use their skills and aptitudes to set up in business.

The IDA was given responsibility for developing a National Linkage Programme to link large industries with suppliers. Initially this was to be in the electronics sector. IDA was instructed to develop this programme around firms and individuals who clearly had potential for success. It was to co-ordinate State support and assistance in marketing, product and process development and quality control during the critical initial phases of such businesses.

Technology Policy

The level of technological development in Irish industry is low and characterised for the most part by a poor record in product and process innovation. While considerable progress has been made by many firms in using new technology, the 1984 White Paper commented that "much of Irish industry needs additional investment in marketing, new technology and product development to survive." It noted a lack of research and development during the last decade as well as a lack of links between educational institutions and both Irish- and foreign-owned industry.

The IDA was authorised to give grants, not exceeding 50%, toward the cost of acquiring new product or process technology from abroad. Besides its responsibility for developing local industry, the IDA promotes Ireland abroad and assists foreign companies in setting up business in Ireland.

The Institute for Industrial Research and Standards (IIRS) is another State agency charged with promoting science and technology in industry. Under the White Paper, "the main task of IIRS will be the seeking out of companies and sectors where growth and process improvements will lead to significant output growth and quality improvement. To achieve this, IIRS staff will be seconded to IDA offices abroad."

Another key State body is the National Board for Science and Technology (NBST), established in 1978 to advise and assist the Government in formulating science and technology policies. It was given the task under the White Paper of developing the application of science and technology to economic development in line with the White Paper's objectives.

The NBST operates a number of schemes in higher education to encourage co-operation between industry and the academic world. There is funding for projects of an applied or development nature undertaken in colleges on behalf of industry. There is a co-operative research and development programme involving manufacturing industry and higher education. And there is a programme -- successfully used by Stet Ltd., one of the case studies -- for the employment of unemployed science and engineering graduates.

To avoid duplication in State services to industry, under the White Paper the NBST and IIRS will have a common board of directors. Further, a Management Committee on Industrial Policy, representing

the agencies providing services to industry, has been set up under the chairmanship of the Department of Industry, Trade, Commerce and Tourism. It will carry out major reviews every three years of the effectiveness of the new industrial policies.

Support and Incentives for Industrial Development

The IDA and the Government operate a range of incentives to help new and existing industry. Most of the companies examined in this study used some of the incentives below:

- 10% Tax: Until the end of this century, corporation tax is set at a maximum of 10%. Industrialists can depreciate 100% of building and machinery, reducing the rate of tax below 10% in some cases.

- Capital grants: The IDA offers cash grants toward fixed assets, including site development. The levels vary between 45% and 60% depending upon industry type and location. The IDA, together with AnCO, provides grants of up to 100% for training.

- Research and development: Grants up to 50% of the costs of R & D projects undertaken by manufacturing firms are being granted.

- Feasibility studies: Grants help existing companies undertake studies of the feasibility of new projects or products.

- Advance Factories and Business Parks: IDA owns some 5,000 acres of serviced industrial sites. It builds "advance" factories on these sites so accommodation is quickly available for new ventures.

THE ECONOMIC, SOCIAL, EDUCATIONAL AND CULTURAL ENVIRONMENT AND HOW IT AFFECTS COMPANY INNOVATION

This section draws on three sources: A recent study by the National Board for Science and Technology (NBST), a report on "Innovation Policy in Ireland" published by the OECD in 1985, and interviews with industry experts. The NBST study identified three areas where barriers to innovation arise: 1) barriers in the broader environment; 2) barriers arising from the nature and structure of Irish industry, and 3) barriers within the firms themselves.

The Broader Environment

A key difficulty is the shortage of "seed capital" to support new venture development, particularly in high technology. This arises from the risk-averse nature of Irish financial institutions and their relative lack of experience in evaluating innovative, high technology projects.

Taxation is also a problem. Capital gains taxes do not differentiate between productive and speculative investment and high personal taxes leave relatively low disposable income for prospective entrepreneurs. High taxes also drive talented and mobile personnel abroad.

There has been a shortage of new ideas over the years, due in part to these other factors: the large number of small companies, an unsophisticated market, the relatively undeveloped nature of the Irish economy and the lack of government action.

Furthermore, lack of interaction between industry and higher education has led to a shortage of technically qualified personnel. The higher education system lacks an understanding of innovation and entrepreneurship, best summed up in the statement that Ireland lacks an innovative culture. This is evidenced in the conservative and rather staid nature of society, politics and culture.

The Nature and Structure of Irish Industry

Irish industry is marked by a large number of small firms producing undifferentiated products. This is reflected in a lack of resources for the development of products and processes, a lack of market power for developing and exploiting innovation and a lack of scale economies in production. The domestic market is small for most industrial consumer products, which limits the ability to launch them for export. Many of the foreign-owned firms carry out no local R & D, nor do they market locally. This limits the long-term potential for innovation and any spin-off of this to other firms.

Barriers within Firms

The biggest problem facing firms is organising and funding their marketing policy. This covers exporting, as well as finding markets and properly trained personnel, and establishing distribution networks and market research. Technology also poses difficulties, varying from sector to sector. Other obstacles are the lack of resources at early stages of development, the lack of R & D, the shortage of scientific and technical staff and the lack of technology transfer strategies. Good ideas are also in short supply.

The inadequate capital structure -- particularly in technology intensive firms -- is reflected in the low level of funds allocated to generating ideas, ensuring quality, and to R & D and marketing programmes. Indigenous managers also need improvement in management and communication, and access to information on trends and opportunities in their fields.

The 1985 OECD report on Ireland mentions all the above barriers to innovation. It also cites a European Management Forum report (Geneva, 1985) listing the industrial competitiveness of 22 OECD member countries. Ireland was ranked 17th. Twenty-nine criteria were evaluated. Ireland was in the bottom quartile in the following categories:

- Strategies toward the future (effective long-term planning
- Innovativeness in firms
- Corporate readiness to exploit inventions
- National creativity (patents per 100,000 residents)
- Expenditure on R & D as a percent of GNP.

The OECD report said there was need for a national strategy to upgrade and reposition Irish indigenous firms. If properly implemented, this could be successful. It stressed the potential innovative capabilities of the large youth population and noted that "the sense of co-operation in small communities for survival and development might be one of the most favourable features of Irish culture" that could be harnessed and developed. Building upon such assets, the report said, would be an approach that would offer a way between total State support and a totally laissez-faire situation.

Technological Park

One Government agency that has attempted to address the problems has been the Shannon Free Airport Development Co. Ltd. In the late 1970s it established a Technological Park in the Limerick Mid-Western Region which is now the location of the National Institute for Higher Education, a College of Education, an Enterprise Centre and an office of the Irish Industrial Development Authority. The idea was to encourage interaction and co-operation between education and industry by combining intellectual and physical resources in one area and thereby overcome artificial boundaries between industry and education. This Park is now planning an integrated approach for high technology, providing facilities for large and small industry (such as Wang and Varian) as well as international service activities and support services.

One part of the complex is the Innovation Centre, established in 1980, which helps start businesses which are Irish-owned, are innovative and export-based. It is a laboratory for people with ideas for new and improved products and it helps train them in entrepreneurial techniques, including creative thinking, decision making and problem solving.

GOVERNMENT TRAINING POLICY AND OBJECTIVES

Pending a possible redefinition of policy expected in 1986, Government training policy objectives are as follows:

- Improve the overall skill level and standards of the labour force;
- Facilitate development of a highly-trained and motivated labour force to establish Ireland as an attractive location for business enterprises;
- Assist enterprises and workers to cope with occupational, structural and technological change;
- Provide persons with the opportunity to acquire skills appropriate to the jobs available;
- Provide disadvantaged groups in the labour market with alternatives to unemployment and improve their prospects of employment;
- Promote equity in access to jobs and training, and
- Ease the transition from school to working life.

AnCO - The Industrial Training Authority

The overall aim of AnCO has been and will continue to be to promote and provide training and development to help achieve national economic and social objectives and, by so doing, to assist individuals to secure satisfying and satisfactory employment and to help business to be more successful.

As the national training authority, AnCO aims to ensure

- That the Irish workforce at its levels of skill will be trained to the highest international standards and be fully competitive with comparable workers in other countries;
- That all persons with the will and capacity to do so can improve their standards of skill so as to increase their earning power and derive greater job satisfaction; and
- That training is provided to assist in the creation of jobs and in regional/community development.

Co-ordination of Education, Training and Manpower Services

As a result of a recent review, the Government has approved a series of measures to improve the co-ordination of education, training and manpower services. Services will be provided in the future in a much improved context as a result of the proposed Manpower Policy White Paper and the reform of educational curricula and structures taking place under the ægis of the Department of Education.

A high-level committee under government chairmanship has been established. One of the committee's main tasks is to develop guidelines for education and manpower authorities on preparing young people for the transition from school to working life.

RELATIONSHIP BETWEEN INDUSTRY/TECHNOLOGY POLICY AND EDUCATION/TRAINING POLICY

Industrial policy is formulated by the Department of Industry and Commerce and implemented by its agencies, while training policy is formulated by the Department of Labour and implemented by AnCO and other agencies. Education policy is the responsibility of the Department of Education with inputs regarding tertiary level education from the Higher Education Authority, the National Council for Educational Awards (NCEA) and the Vocational Educational Committees.

The Industrial Policy White Paper as well as the Government's Action Programme for Education [18] earlier in 1984 both stressed the need for stronger links between higher education and industry.

Higher Education and Industry Co-operation

The policy of developing Ireland as a centre for high-tech industry, adopted in the early 1970s, meant that the environment to support this technology had to be strengthened. This involved restructuring technical education.

All tertiary-level institutions were encouraged to develop curricula so that the demands for graduate and technical staff would be met. New colleges and laboratories were built. Some 60% of the institutions which issue degrees, diplomas and certificates were established during the last 15 years. There has been a dramatic shift in the number of students moving to engineering and science away from traditional courses. In 1983, 61% more students registered for mechanical, electronic and electrical engineering courses than in 1978. Commerce, business and other scientific studies saw increases as well, while attendance at architecture, medical and law schools declined. Several companies examined in this case study (especially Kollmorgan) developed close ties with tertiary-level educational institutions.

The White Paper on Industrial Policy stated that co-operation between State agencies, industry and higher education has not been sufficiently developed. In education, there are many well-qualified people whose skills and talents have not been used beyond their normal academic duties. A pilot programme, developed jointly by the IDA and the NBST, has been launched to promote more comprehensive co-operative research between industry and higher education. The objective of the programme, funded jointly by industry and the IDA, is to make the technological skills of specialists in higher education

available to industry and make this education sector more aware and responsive to industry requirements.

To encourage greater links between tertiary education and industry, funds will be provided for additional research in product innovation and development to be carried out by tertiary-level institutions.

Research and Development Links

The Irish universities are moving to meet industry's needs to produce graduates in computer science, applied physics, electronics, and industrial and electrical engineering. For example, University College in Cork is the home of the National Microelectronics Research Centre. The centre has a large number of research and development contracts involving collaboration with industry in Ireland and the United Kingdom. At University College, Galway a biotechnology plant -- one of the very few in Europe -- has been built as a joint enterprise of the university and the Institute for Industrial Research and Standards. At University College, Dublin, a University Industry Centre was opened in 1985. It serves as a meeting place for the exchange of information, ideas and research between the university and the world of commerce and industry.

Major expansion has also taken place at the tertiary, non-university level. Regional Technical Colleges have been set up around the country on lines similar to Dublin's two Colleges of Technology where the focus is on vocational education and training for new technology. In Shannon and Limerick close ties have been developed between the National Institute for Higher Education (NIHE) and local industry. A scheme called Co-operative Education requires that all NIHE students in Limerick and Dublin spend one academic year gaining practical experience in industry. Students are paid by the company where they work and their activity is monitored by the company and the NIHE academic staff. More than half of NIHE's graduates have job offers before their graduate.

At another level, the Shannon Development Company has established an Industrial Support Foundation to identify the expertise which exists in the NIHE, Limerick, so that this can be used for R & D by local companies.

In an effort to improve deficiencies in Irish marketing, AnCO is collaborating with University Colleges in Dublin and Galway to provide marketing training for new graduates. Twenty-four graduates from each college are given practical work experience and training in marketing each year, working 30 weeks in selected companies.

AnCO also organises a Technical and Managerial Sponsorship Scheme in association with the IDA and sponsoring American, West German and Japanese companies. This provides top-grade graduates with a

chance to develop their major disciplines and acquire management skills. In 1985, 60 graduates embarked on a two-year training course.

Furthermore, Shannon Development Company and the NIHE in Limerick have joined to organise a 20-week Entrepreneurship and High Technology Programme to prepare potential entrepreneurs to start up their own high-tech companies. When the programme is finished, the participants will have prepared a plan for a high-tech company based on identified products, will have examined markets and be theoretically prepared to launch their own companies. The majority are employees from industry but a few final year tertiary-level students are also admitted.

School-Industry Links

In line with the need to bring schools and industry closer together, a number of schools already run pre-employment courses in which pupils spend some time in business or industry, and in eight localities school/industry schemes have been established. The Federation of Electronic and Informatics Industries, affiliated to the Confederation of Irish Industry, also has a scheme where career guidance teachers may work in electronics companies to familiarise themselves at first hand.

All these schemes are being expanded and the recently established Curriculum Examination Board has been asked to review curricula at secondary level with a view to improving the technological level. The Department of Education also has a programme to review teacher training to make sure that teachers are aware of industry needs.

The Departments of Education and Labour also have been asked to draw up a system of "second chance" employment-oriented education for persons who left school early and are deficient in literacy, numeracy and oral skills.

PLANNING OF TRAINING

Planning of training is along guidelines established by the Ministry of Labour which is responsible for manpower planning and policy. AnCO plays an important part in providing vocational training and in retraining workers.

The Role of the Industrial Training Authority, AnCO

The Industrial Training Act of 1967, which established AnCO, says that AnCO may "carry on or assist persons in carrying out research into any matter relating to training for the purposes of any activity of industry." Since its establishment in 1973, a great deal of research has been carried out by AnCO's Planning and Research Division which has two main departments: Research and Planning, and Development and Standards.

The Development and Standards Department is responsible for developing training programmes and products, with recent emphasis on the techniques of open learning and computer-assisted training. It researches and validates programme needs and outcomes, sets and assures quality and standards, certifies training courses and their outcomes, and provides a selection and testing service. The Research and Planning Department is responsible for researching and surveying manpower and occupational training issues and needs; providing local labour market information for planning and policy making; liaising with other training research organisations; conducting research into training methods; evaluating programmes and operating information systems and services.

In 1984 AnCO conducted a strategic planning exercise which openly examined the basic mission of the organisation, its strategies and policies. A five-year plan was submitted to the Minister of Labour, outlining the major contribution that systematic training could make to the nation's economic and social plans, particularly in the field of technological innovation.

Development of Planning Strategies

Several important reports have reviewed the planning of training in Ireland and AnCO has taken cognisance of them. A 1973 OECD team identified the serious inadequacies in manpower information existing then. It called for research to provide information required for proper planning of training. In 1982, the Telesis report ("A Review of Industrial Policy") and the National Economic and Social Council's conclusions about this review, also commented on inadequacies in manpower information and called for further research on manpower needs for industrial development. An Irish Parliamentary Committee Report on Public Expenditure in 1984 recommended the development of training performance measures. It called for "adequate planning by AnCO to meet the training or retraining needs of the 15-25 years of age group who may face unemployment in later years." A further report on Manpower Policy in Ireland published in 1985 by the National Economic and Social Council urged the Government to take steps toward establishing a more clearly defined Labour Market Policy. It recommended great coherence and co-ordination in the manpower sphere stretching across a number of Government departments. It recommended greater emphasis on monitoring new technologies and urged Irish industry to pay more attention to manpower planning.

The Department of Labour expects to publish a Manpower Policy White Paper shortly.

Feedback Mechanism between Training Agencies and Industry

AnCO's communications with industry and education are mainly channelled through its governing Council and seven Statutory Industrial Training Committees which advise the Council.

The Council is the decision-making body. It comprises a Chairman and 13 ordinary members. The membership is made up of five employers' representatives, five workers' representatives, one educational representative and two representing the Minister of Labour. The Irish Congress of Trade Unions names the five workers' representatives. Two employers' representatives are named jointly by the Confederation of Irish Industry and the Federated Union of Employers. A third is a nominee of the Construction Industry Federation, the fourth is named by the Society of the Irish Motor Industry and the fifth is nominated jointly by the Irish Printing Federation and the Irish Master Printers Association. The educational representative is appointed after consultations with the Minister of Education, while the Minister of Labour directly appoints the Council Chairman and the remaining two Council members.

The seven Statutory Industrial Training Committees which advise the Council are made up of employer, worker, and educational interests from each of seven different industrial sectors. Each committee has its own independent Chairman. The committees presently operating are from these sectors:

- Textiles
- Clothing and Footwear
- Food, Drink and Tobacco
- Engineering
- Construction
- Printing and Paper
- Chemicals and Allied Products

Each committee holds office for three years. One main function is to approve and review grants for training within their respective industrial sectors. In 1984 aid under the levy grant schemes amounted to IR £14.5 million. From time to time the committees have promoted sector studies, for example in the construction and motor industries. A source of information on industrial requirements is AnCO's Training Advisory Service which administers the levy grant scheme and stays in close touch with industry through regular visits to companies.

Policy Co-ordination in Manpower Training and Industrial Development

At Government level co-ordination between industrial and technological policy and policy on education and training is established in numerous ways. The Government Departments with responsibility for these policies and their agencies -- the Industrial Development Authority, the National Board for Science and Technology, the Higher Education Authority, AnCO and the National Manpower Service -- maintain contact through the Manpower Consultative Committee set up by the Minister of Labour. This committee includes representatives from both sides of industry. Through its sub-committees it has examined such major questions as the supply of and demand for

engineering and technician skills and the links between education and training.

At the regional level Regional Manpower Committees also examine the labour supply and demand situation. Regional Small Industry Advisory Councils have been established to improve State services to small business. Under the direction of the IDA, these councils advise on education and training, industrial innovation and linkage as well as quality concerns.

At local level the recently established Community Training Employment Consortia (COMTECs) are of considerable significance. These were established under the Youth Employment Agency to bring manpower and education authorities at a local level together with community organisations to ensure co-ordination of training of young people.

While all the above bodies are either Government administered or sponsored, the Sectoral Development Committee, although it includes Government representatives, operates independently of the State structure. Each industrial sector has its own Sectoral Consultative Committee which examines the needs and efficiency of each sector and makes recommendations.

STRUCTURE AND PERFORMANCE OF THE TRAINING SYSTEMS

AnCO - The Industrial Training Authority

AnCO, as the principal State training agency, is funded by the Central Exchequer through the Department of Labour. A large percentage of these funds come from the Youth Employment Levy with further funds received from the European Social Fund.

The day-to-day administration of AnCO is managed by the Director-General who is responsible to the governing Council. Reporting to him are a Deputy Director-General and five Directors for Personnel; External Training; Training Advisory Services; Training Centres; and Finance & Administration, Planning, Research and Development.

AnCO is involved in the following major activities:

1. Training Advisory Service

The work of the service includes company visits, promotion of levy/grant schemes, consultation with the Industrial Training Committees, co-ordination of training facilities, responsibility for

apprenticeship training and validation of training grants for the Industrial Development Authority.

Training of employees primarily is the responsibility of the employers who are encouraged to ensure training by means of the levy/grant system. All manufacturing and construction companies above a certain minimum size (approx. 15 or more employees) must pay a levy of 1-1½% of their wage bill. If approved training is undertaken, up to 90% of the levy is refunded to them. AnCO collects the levy, agrees on and monitors training programmes and approves refunds of the levy. Up to 10% of the levy can be used by AnCO to administer the scheme with any remaining funds (surplus levy) being allocated to special training schemes. In 1984, 4091 firms were levied, bringing in IR £13.7 million compared to IR £5.4 million in 1977. Refunds amounted to IR £5.1 million in 1977 and IR £13.08 million in 1984.

There are some 5,524 training managers and instructors operating in firms in Ireland employing 80% of the workforce. A total of 14,119 firms employing 303,296 workers are or have been assisted by 150 AnCO Training Advisers. The personal relationships built up between the training managers and the AnCO advisers helps AnCO and the Industrial Training Committees identify industry's major needs. In 1984 314 new projects involving IR £26.4 million were recommended for training 10,588 people. In addition, IR £10.3 million in respect of 175 domestic industry grant applications was approved to facilitate the training of 7,139 persons.

All the companies examined in this study benefit from advice and support from the AnCO Training Advisory Service. In fact firms employing more than 87% of the nation's manufacturing and construction workforce have established formal training functions with the stimulation and support of AnCO.

2. Training Centres

AnCO provides facilities at its 18 Training Centres for training unemployed and redundant workers as well as training apprentices and updating the skills of other workers. The Centres provide programmes which de-emphasise traditional courses and reflect the new changes in technology. For instance, the Loughlinstown Training Centre in Dublin specialises in training for new technologies and the development of computer-based learning. AnCO stresses the concept of training for "families of jobs" which helps the trainee's versatility and increases his or her employment prospects.

More than 26,761 people of all ages were trained by the Training Centres Division of AnCO in 1984 and 69% of those trained in specific employable skills were placed in employment.

3. Apprentice Training

One of AnCO's statutory responsibilities is the training of all registered apprentices in a number of designated trades. Employers, however, are regarded as playing the major role in providing on-the-job experience. A new apprenticeship system was introduced in 1975 which added off-the-job training in approved centres, courses in educational establishments, standard training and educational criteria for each trade and a system of testing and certification. The general framework of apprenticeship now is in line with that in most European countries. The total number of apprentices in 1984 was 16,636. Due to the high unemployment of apprentices in recent years, the cost to the State has risen and AnCO is currently discussing proposals with labour and management to revise the system.

4. External Training

In 1979 AnCO set up a new operating division to provide training for the unemployed. The External Training Division seeks out spare training capacity in industrial, commercial services and education sectors. The method of sub-contracting training to outside or external agencies allows AnCO to provide flexible, responsive and wide-ranging programmes. Since it was set up, this division has increased training from just over 1,000 trainees in 1979 to more than 14,000 in 1985.

Nearly 200 different courses have been developed during this period with increasing emphasis on enterprise-type courses such as "Start your own business", youth enterprise programmes, product development or design and export-marketing courses.

Irish Management Institute (IMI)

The Irish Management Institute is a voluntary independent organisation owned by its members. Its brief is to develop effective managers for Irish business. It runs a wide range of courses in managerial development in conjunction with AnCO for managers and redundant managers. Its funding comes from a variety of sources including a state grant and European Social Fund aid. Further assistance is available from the technical assistance grants scheme for which some IMI course participants are eligible. Several companies examined in this study used IMI courses to train their managers.

Shannon Development Company

The Shannon Free Airport Development Company, established by the Government in 1959, was assigned a special task in 1978 of promoting small indigenous industry in the mid-West region of Ireland in an intensive and innovative fashion. It is hoped that lessons gained from this pilot programme will benefit the promotion of small industry throughout the country. The Shannon Development Company support programmes include providing fixed asset grants, business advisory services, small industry management training, and product development services through the Small Industry Innovation Centre. The Shannon Development Company was instrumental in establishing the National Microelectronics Applications Centre.

Youth Employment Agency (YEA)

YEA was established in 1981 to provide training and employment for young people between 15 and 25. Its responsibilities include

- Overall national responsibility for furthering the employment of young people
- Co-ordinating and extending youth employment, training and work experience programmes
- Helping young people to create their own job opportunities and promoting self-help and enterprise among them
- Assisting voluntary, social and community organisations in the provision of jobs for young people.

In establishing YEA, the Government also introduced a 1% levy on all personal incomes to finance YEA's programmes. In 1984 IR £83.25 million was raised from this Youth Employment Levy, compared to IR £69.83 million in 1983.

COMTECs

In 1985, Community Training and Employment Consortia (COMTECs) were launched on a pilot basis by YEA. These aim to improve the effectiveness of manpower services for young people by creating local manpower planning and delivery systems geared to local needs. The COMTECs are expected to come up with recommendations on the mix and scale of youth training and employment programmes and establish effective linkages with Vocational Education Committees, secondary schools, the youth service, etc. Comprising representatives from a broad range of local agencies and organisations, COMTECs are making a start toward greater decentralisation of decision-making.

ENROLMENT POLICY

AnCO provides adult training courses for persons aged 16 or over who have left school. There is no upper age limit. Applicants first complete an application available from AnCO's 18 training centres, its head office in Dublin or from any of the National Manpower Service's 44 local offices. They then are called for an aptitude test and an interview to determine the courses for which they are best suited.

The courses are open irrespective of age, sex, educational qualifications or marital status. Trainees come because they have been made redundant and wish to acquire new skills, or because they are sponsored for new skills training by their employers, or because they themselves wish to enhance their job opportunities. Some specialist skills may require special educational qualifications. In 1984, more than 60,000 persons applied and 40,020 were trained on adult or apprentice courses.

The National Manpower Service (NMS)

The National Manpower Service was established in 1971 with these objectives: to place job-seekers in the employment best suited to their abilities and inclinations; to secure for employers the workers best suited to the needs of the work on offer; to directly administer certain employment schemes aimed at the alleviation of unemployment; and to operate an Occupational Guidance Service for persons who have difficulty in getting or changing jobs.

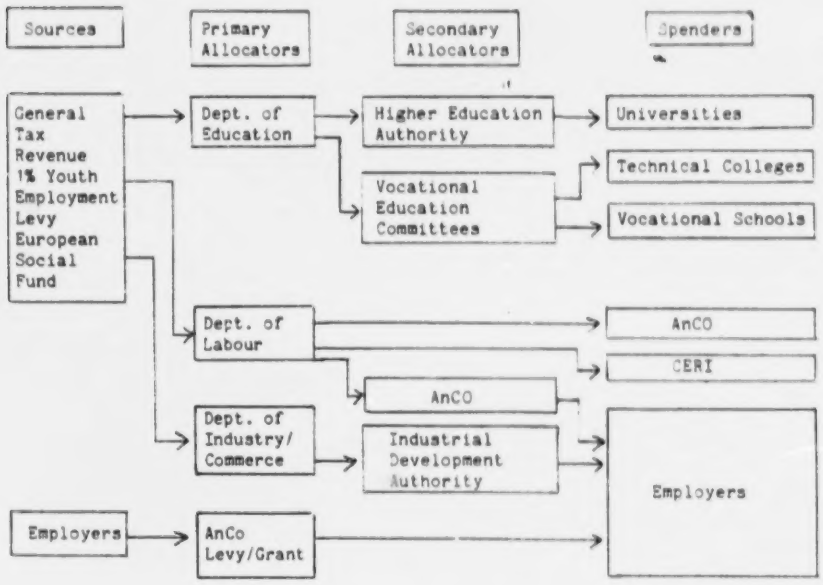
The Guidance Service provides specialist advice and guidance to job-seekers with problems of occupational choice and assists them reaching informed decisions about their choice of career. A job-seeker who registers with the NMS is referred to the Guidance Service if it is felt he or she would benefit.

NMS provides career talks in schools and is involved in the selection of apprentices. It maintains a close working relationship with employers' and workers' organisations, with educational and training authorities and with State agencies and other bodies involved in industrial and economic development. Norco Ltd, examined in the case studies, worked closely with the NMS in recruiting staff. There is day-to-day co-operation at local level between local NMS officers and other agencies, especially AnCO.

The NMS is part of the Department of Labour and it has eight regions. Its operations are paid by the Department of Labour.

THE SYSTEM OF FINANCING AND INCENTIVES FOR TRAINING

Main flows of funds in vocational education and training in Ireland



Source: State Funding of Vocational Education and Training in Ireland (7)

The above diagram outlines the general allocation of funds for training. The Department of Labour is the principal allocator of funds, receiving its money from the Central Exchequer which relies on the General Tax Revenue, the Youth Levy and the European Social Fund.

State spending on manpower, training, education, job creation and unemployment schemes increased from IR £324 million in 1977 to IR £779 million in 1981. Of the IR £83.25 million raised from the Youth Employment Levy in 1984, IR £12.1 million was made available to the Youth Employment Agency itself for youth training and job creation schemes, more than double that of the year before. The Youth Levy, together with contributions from the European Social Fund, finances almost all training for young people not in employment.

European Social Fund

Training for older persons is funded through normal Government tax revenues plus the European Social Fund (ESF). Ireland, as a priority region in the EEC, is able to recover from the European Social Fund 55% of its expenditure on the training of the unemployed. Flows from the European Social Fund to Ireland began when Ireland joined the EEC in 1973 and totalled IR £4.1 million in that year. Net approvals from the Fund went from IR £53.5 million in 1980, through IR £123.5 million in 1983 to IR £158 in 1984. The major beneficiary is AnCO. Four of the companies examined in this study (Kollmorgan, Ardmore, Crown and Norco) conducted training programmes with ESF support.

Wage Levy/Grant Scheme

The 1-1½% levy, described earlier, which is imposed on the wage bill of manufacturing and construction companies allows grants to be made for training of apprentices and technicians, for recruitment and training of graduates and for providing training opportunities for undergraduates. Miscellaneous grants are paid from surplus levy funds. The grants change from year to year, depending on the current needs of industry.

Technical Assistance Grant Scheme

The Technical Assistance Grant Scheme, financed directly by AnCO, provides grants of up to 50% to manufacturing and wholesale and retail distribution organisations toward external courses for managerial and supervisory staff. Nearly IR £1.3 million was paid out under this scheme in 1984.

New Industry Training Grants

Grants to new and expanding firms in the manufacturing and service sectors are funded by the Industrial Development Authority, the Shannon Free Airport Development Company, and Udaras na Gaeltachta depending on the location of the industry. AnCO covers training and wage costs for those in training and acts as consultants by approving and monitoring training programmes. Stet Engineering, one of the companies in this study, availed itself of a New Industry Training Grant.

Domestic Industry Training Grants

These grants, paid toward the development of existing firms, are funded by the IDA and administered by AnCO. They are usually given for the introduction of new technology, the expansion of output or a change to a new product line. During 1984, 175 applications were approved for training projects at a cost of IR £10.3 million for 7139 trainees.

Scholarships

Scholarships, provided by AnCO to ensure well-trained people for new and existing jobs, cost AnCO IR £78,064 in 1984.

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TRAINING IMPLICATIONS OF TECHNOLOGICAL CHANGE IN MANUFACTURING IN NEW INDUSTRIAL COUNTRIES: THE IRELAND CASE

PART 2

EXPLANATORY NOTE

At the end of five of the following case studies, 13 hypotheses, provided by the ILO, were tested. The hypotheses are as follows:

1. The firm has a good past record of marketing new/adapted products or introducing new/adapted processes.
2. The firm exhibits considerable flexibility in work organisation/labour use/deployment of labour.
3. The Government strongly supports technological innovation/introduction of new technologies by industrial policy measures.
4. The firm is able to recruit and retain personnel at the desired levels of recruitment.
5. Personnel skills are a determining factor for success in market competition.
6. Some skills/personnel groups are more important for company survival/success than others.
7. The new technology has meant genuine skill enhancement.
8. The firm has a high ratio of research/skill intensive manpower to total workforce.
9. The Government strongly supports development of skills for high-technology industries by means of training and educational policy measures.
10. The firm has maintained close collaboration with university and education and technical training institutions and has influenced their courses to mutual benefit.
11. The firm has strong affiliations with foreign firms and/or institutions providing technological backup and training.
12. The firm acts as a considerable "diffuser" of skills to subcontracting/supplying firms.
13. Trade unions or workers' representatives actively participate in decision-making regarding employment, training and output.

INLAND KOLLMORGAN LTD

Company profile

Kollmorgan (Ireland) Ltd was established in 1973 in Ennis, County Clare. It is owned by the Kollmorgan Corporation in Connecticut, USA. It manufactures precision motion control components and employs 164 people. A recent announcement revealed plans to establish a new plant which will produce specialised power supplies for use in data processing, telecommunications, medicine, etc.

In 1980 the company was faced with a product range that was becoming out of date. The company felt it had to "innovate or die". To meet the problem of a declining share of the market, the company needed new high-technology products which would provide a new competitive edge. Market research was carried out in seven major industrial countries and a decision was taken to design and develop a state-of-the-art product for Europe's high-technology market. A research and development facility, which now employs 38 people up to Ph.D. level, was established in Ennis and a three-year R & D programme was undertaken with IDA grant assistance.

In 1981 Kollmorgan (Ireland) became an autonomous operating division. The Irish management assumed responsibility for setting future marketing and product development strategy. It was decided to establish the marketing and technological capability to be a specialist supplier of control equipment to the robotics and automation equipment sectors. The overall objective was to become a centre of technical excellence in precision motion control. This led to a change in the company's personnel structure. While 11% of employees were graduates in 1981, this figure rose to 28% in 1985, reflecting the emphasis on high technology.

The following table shows the change in the company's profile between 1980 and 1985:

	1980	1985
Sales (adjusted for inflation)	IR £6.4m	IR £8.5m
Value added to product (%)	55%	60%
Productivity (% increase since 1980)	-	75%
adjusted for inflation	IR £ .82m	IR £1.7m

The R & D programme involved close work with experts in University College in Cork, University College in Dublin and the National Institute of Higher Education in Limerick in the areas of electromagnetics, power electronics and control engineering. These linkages extended research and development by the effective addition of eight professors and lecturers. The linkages were in research

contracts. They involved motivation of the university researchers by the company and close ongoing management of each project.

Technical Innovation

The company feels that if it had not revitalised its product portfolio from 1980-81 onwards, it would not be in business today. The product range before 1980 was becoming technologically unattractive and uncompetitive.

Kollmorgan uses a combination of methods to identify new products. Sales engineering, design engineering and senior management focus attention on specific new products, market niches and licensing. Having identified the market niche, the company designs and develops the product for it. While this means that the company mainly operates via "market pull" , there is also a significant "technology push" because of the strong R & D. The company now has developed a range of "state-of-the-art" products on which it holds all patents. New markets have been identified and will be developed over the next three years. The company estimates the market for its products in Europe is increasing by 15% a year.

The planned new IR £3.3 million plant is expected to employ 150 people in 1988. A new system which will be produced is the result of a technology acquisition agreement with the American company. Due to a worldwide demand for reduced size and weight in electronic equipment, the company expects to be in a growing market. Independent experts predict that the market for switch mode power supplies in Europe will increase from IR £1.8 billion in 1984 to IR £3.9 billion in 1988.

Support for innovation

All capital expenditure on R & D equipment received assistance in grants of 35% from the IDA. There was also 50% grant aid for R & D expenditure and expenses of feasibility studies. The company also received an AnCO/European Social Fund grant to retrain both the existing workforce and new workers between September 1983 and September 1985. The company is eligible for tax relief on products which are exported and it received a grant from Coras Trachtala (the Irish Export Board) for recruiting a sales engineer to work in Germany and for producing promotional material.

In general, the company is satisfied with the State support it receives but feels that all its new projects still require major expenditure outside Ireland and this gets no support. It also feels some of its in-house training could be considered a more up-to-date

form of apprenticeship which warrants consideration for State funding.

Manpower Use

The company found the situation in Ireland relating to well-trained engineers to be a vital element in its ability to start its programme of design/development. Because there was a lack of designers in 1980, the company decided to hire motivated, technically brilliant graduates with little industrial experience and train them in-house and with external training. Combining this with a dynamic approach to product development, the company was able to turn the engineering graduates into top design engineers in just two-three years, a process that normally takes 5-8 years. The company believes that major factors were the innovative and flexible technical atmosphere in-house and a system where achievement was recognised with good rewards.

Because of the advances in design technology, workforce skills at technician and junior technician level also increased greatly through in-house and external training. The company believes R & D is the cornerstone of its marketing and new product development, but that it also requires skilled personnel at all levels so it can respond rapidly to changes in the marketplace.

The company has no difficulty retaining personnel at the various levels and 70% of the workforce has been with it for more than five years. However, their advanced training and skills make the personnel vulnerable to job "poaching" approaches from outside the country. Irish engineers are highly rated on the world market and there is a shortage of such staff in the United States.

In an effort to speed up the incubation of new products from their concept to sale, the company established prototype cost centres which reduced the cycle from 18 to 24 months to between 6 and 12 months. Each cost centre was established as a "business", so that a feeling of ownership developed around each product with communication and participation of all levels of personnel in the developing and manufacturing of the product. This significantly increased productivity.

Training Programmes

The company is committed to the further education of all staff and it operates an in-house support scheme to facilitate this. It runs in-house courses and, where appropriate, also uses the expertise of external agencies such as AnCO or the Irish Management Institute.

The company needs staff with multi-skills capability in each of the cost centres where they work. It particularly needs people who can understand customers' demands and respond to them. In 1982 six employees initiated a dual-technician training programme which provides mechanical and electronic skills. To aid this programme, the local Vocational Education Committee now runs City and Guilds courses for such technicians. The company programme involves placing staff in sister companies in France, Germany and the United Kingdom where experience is gained of customer needs, the company's foreign installations and foreign languages. The company makes it a prerequisite that in-house staff take the City and Guilds examinations which provide a mix of mechanical and electronic skills. In 1984, 20 persons attended the appropriate classes in the Regional Technical College.

The company does not have its own in-house training department. It organises courses on- or off-the-job as is appropriate. It pays 70% of the cost of outside courses.

Over the last four years, product quality, as determined by warranty costs, has improved by more than 50%. There has been a significant improvement in productivity -- approximately 18% a year since 1983. Targets in relation to quality and quantity have been achieved.

Skill Diffusion

The company obtains 58% of its raw materials in Ireland and works closely with its key suppliers. Subcontract work currently is out to at least 30 suppliers, who are supported by input from the company's process and design engineers. In certain cases, subcontractors' employees have been brought into Kollmorgan to learn necessary skills and, when needed, Kollmorgan supplies the subcontractors with skilled personnel to run local in-house training.

Worker Participation in Decision-Making

Approximately 45% of the company's workforce has been unionised since the union came into the company three years ago. When 75 people were made redundant early in 1983, the company had a workforce of 150. It is now 164. At that time, the union agreed that flexibility within the company would be high and it agreed to the introduction of new technology and revised work practices. That agreement has continued until now. All management decisions are communicated through supervisors to each section and employee. Input from operatives is welcomed and encouraged. There is no formal discussion with the union in decision-making. There is a works

committee which has management and worker members but it is not a negotiating body. It discusses and highlights existing policy, rather than deciding policy. The union considers the manpower and training policies of the company to be good and feels that employees have good opportunity for developing their skills.

Testing of hypotheses

1. Past Record
The firm's history of marketing new products is recent. It was brought about by the realisation in 1981 that it had to move "up-market" to retain viability.

2. Flexible Labour Use
Over half the company's manufacturing personnel have more than one skill and can move from section to section. There is an additional pool of 15-20 multi-skilled personnel who rotate as workloads demand. A flexible working environment produces top-class design engineers in half the normal time. Establishment of cost centres has helped in-house communication and participation.

3. Government Technological Support
The company received R & D and feasibility study grants and feels State support is invaluable for survival and innovation.

4. Personnel Recruitment
The company has had no difficulty recruiting engineers and training them itself and is able to retain personnel at the desired levels.

5 & 6. Personnel skills
The skills of the workforce at all levels, but particularly in R & D, are vital.

7. Skill enhancement
Because of advances in design technology, workforce skills have been improved through in-house and external training.

8. Proportion of highly skilled manpower to total workforce
The percentage of graduate employees rose from 11% in 1981 to 28% in 1985, reflecting the higher technology.

9. Government Support for Training
The company feels State support is invaluable. It accepted an AnCO/ESF grant in 1983-85 to retrain its workforce.

10. Links with education/training institutions
It has had very close links with University Colleges in Cork and Dublin and NIHE in Limerick through research contracts. The local Vocational Education Committee ran City and Guilds courses for technicians at company request.

11. Links with foreign firms
Although American owned, Kollmorgan (Ireland) is autonomous with full responsibility for marketing and product development. A new plant, opening in 1988, will produce specialised power products resulting from a technology acquisition agreement with an American company.

12. Diffusion
The company obtains 58% of its raw material in Ireland and works closely with its key suppliers.

13. Worker participation
All management decisions are communicated downward. Discussion is encouraged. There is no formal discussion with the union as a separate body. The Union agrees to a flexible approach within the company and a works committee discusses issues of concern to management and workers.

STET ENGINEERING COMPANY LTD.

Company profile

Stet Engineering is a small Irish-owned company manufactures mould tools. It was started in 1978 by its owner, Mr Gerry Callan, in a shed in Sligo with three employees. In 1980 it moved to new premises on the IDA Finisklin Industrial Estate. It now has 32 employees, 28 of whom are either toolmakers or toolmaking apprentices.

Ninety percent of the company's turnover is from exports, mostly to the USA. Sales grew from IR £250,000 in 1983 to IR £500,000 in 1984 and in 1985 were running around IR £750,000. The company's products have a very high value-added content. Raw materials are approximately 10-15% of overall costs. Most of the remaining expense is for forming the moulds. There is CNC milling, lathe and spark eroder equipment in the plant while one of the CNC milling machines can be run from a CAD system.

Investment in new equipment was around IR £90,000 in 1984 and was running between £80,000 and £90,000 in 1985. Since it started operations, the company has invested around IR £750,000 in new equipment. Its mould tools are designed and drawn by a specialist design company (Techno Ltd., Sligo) which is located close to Stet on the same industrial estate. The two companies are linked by a fibre-optic cable and both companies made the agreement which led to the purchase of the hardware and software needed for CAD and CAM. In this study, we examine the implications and rationale behind the introduction of the CAD/CAM process by Stet Ltd. The introduction of the equipment had training implications for Techno Ltd. and these are therefore included in this case study. Techno Ltd. was set up in 1975. It was a two-man business engaged in design until 1982. It now employs 11 persons.

Innovation

The specific innovation examined is the introduction of a CAD/CAM application within Stet Ltd. The system was commissioned around January 1984. The hardware comprises a central computer and four terminals within Techno Ltd., and a terminal within Stet Ltd. which is linked to a CNC milling machine.

A tool mould is produced in three stages: 1) the product drawing; 2) the tool design/drawing, and 3) the tool manufacture. The Computer Aided Design applies to stages 1) and 2), while Computer Aided Manufacture is involved in the third stage. After Techno Ltd. is given

a product drawing by Stet, it produces a tool design/drawing (actually the "female" shape of the mould). Then, using conventional techniques, toolmakers within Stet plan the method and sequence of operations to make the mould tool from the details on the tool drawing. This usually entails trigonometrical calculations to ensure that the geometry of the mould is correct. In complex moulds, this can be time-consuming and subject to errors. They then write an appropriate programme and input it to the CNC machine tool controller by keyboard. This is known as manual data input (MDI). The programme can also be fed from paper tape.

The advantage of CAD is that once the geometry for a product has been input at the drawing stage, it is possible to access it again at the other two stages of production. In the past, calculations were re-made at each stage. CAD also stores details of standard components which can be specified for a wide range of tools. As for CAM, its software can input tool drawing details to the CNC milling machine tool controller, cutting out the need for a toolmaker to make additional complex calculations or carry out manual data input. At the moment, this CAM facility has not been fully utilised at the plant and MDI is still the norm.

There were three main reasons why Stet introduced the CAD/CAM systems. These were:

1. Customer demand for high quality. Three-dimensional shapes are conventionally very difficult to produce accurately. CAD/CAM is regarded as being the only real way to produce the required quality.
2. Shorter product-life cycles. The market is demanding products with shorter life cycles. Therefore the whole production process has to be speeded up and CAD is needed to facilitate this.
3. CAD is economical and is appropriate to use when there is considerable geometry and complexity associated with the product.

Marketplace competitiveness was regarded as the major reason for new technology. The Managing Director often refers to similar companies in the U.K. which have not adapted and have consequently gone out of business. He himself travels overseas on business and attends as many trade shows as possible on such visits to keep abreast of market developments. He sees ideas which can be introduced immediately and keeps a new ideas file for future development or introduction.

Support for innovation

As mentioned earlier, the CAD/CAM and both its hardware and software were a joint venture of Stet Ltd. and Techno Ltd. The equipment was very expensive and various sources of finance were examined. One source was a customer in Germany who assisted in the purchase. However, 60% of the total cost came from an IDA New Industry Grant. The grant was one of the most important influences on the decision to innovate. A lecturer in robotics at University College, Dublin (UCD) and an official from the National Board for Science and Technology (NBST) also provided technical assistance. The NBST and UCD agreed to support the hiring by the company of a UCD graduate for a two-year period so that he could write advanced software specific to Stet's contract toolmaking. The company pays his wages but is reimbursed 75% in the first year and 50% in the second year by the Youth Employment Agency. A second graduate has been taken on by Stet under the Young Scientists Scheme to work on R & D projects. When the two companies bought the CAD/CAM system, they acquired software that had to be tailor-made to their needs. They were not overly optimistic that taking on a graduate, at the suggestion of NBST/UCD, would be effective. But "as it happens, it has worked out well," one of the managers said.

Furthermore, Stet has made full use of AnCO's first-year off-the-job scheme whereby most of the company's toolmaking apprentices have been trained for their first year in an AnCO training centre. During the remainder of their apprenticeship, the young workers spend two "block-release" training programmes in the Sligo Regional Technical College.

Recently advice also has come from Bayer Ltd. in West Germany which invited Stet's managing director to attend a seminar on tool design in Germany.

Manpower Use

Stet's managing director regards the company labour force as being adaptable and receptive to new technology. Nearly all apprentices have come from AnCO and the director takes the view that it is essential to upgrade the skills of his workforce on an ongoing basis. Many Stet Ltd. apprentices have found mention among AnCO's "Apprentice of the Year" awards, including the 1985 Toolmaker of the Year. The managing director is critical of multinational companies which advertise for fully trained personnel but do not have a training programme as comprehensive as Stet's. In general, the company does not have problems retaining staff although it did lose two of its best toolmakers to multinational toolmaking companies last year. Stet Ltd. has not had to recruit from outside to meet any "skills-need gap",

although one graduate was hired to work on programming within Techno Ltd. and another graduate is being recruited to work on R & D projects.

Stet Ltd. has never had to lay off people so it does not have any defined policy on redundancy. Job descriptions have been completed for all personnel so that employees have their duties fully outlined. There are no staff engaged solely in work or method study. Work is analysed as closely as possible on an ongoing basis, especially if something goes wrong. There is also an ongoing analysis of training needs, and persons seen as having talent progress faster.

Training

Training for the use of CNC equipment was provided by Sligo Regional Technical College two nights a week for two to three months. The CNC supplier also arranged a one- to two-week course. The managing director was the first on the CNC course, and was followed by two groups of six other people. When the spark-eroder equipment was introduced, two weeks' training was given to a company employee by the supplier.

Nine people were initially trained to use the CAD/CAM system. Eight of these were draughtsmen from Techno Ltd. and one was a toolmaker who had done draughtsman's work within Stet Ltd. and will be the company's main CAD/CAM operator.

The CAD/CAM system, which was manufactured by Craftec in the United States, was supplied and installed by the British distributor Engineering Computer Services (ECS). ECS came to Sligo for four one-week periods. However, the British company did not have experience in tool mould design and so most of the training with Techno Ltd. and Stet Ltd. has been direct on-the-job experience. In the first year after the system's installation early in 1984, 50% of the time of the nine trainees was spent on-the-job training. CAM training began about nine months after the CAD and is still going on. There are further potential applications of the CAM system. There has been an increase in the skill levels of men trained on the CAD system, while the system itself has reduced the possibility of mistakes in geometry.

Although over the short term it is difficult to assess the success of the training, the managers of both Stet Ltd. and Techno Ltd. regard it as essential for long-term viability. The quality of work is regarded as satisfactory and delivery times have been very good. A recent letter to Stet Ltd. from the United States expressed appreciation for the fast delivery of a supply of moulds.

Decisions on the introduction of new technology in Stet Ltd. are made by the managing director. There are no company collective bargaining agreements. However, discussions with personnel are held prior to the introduction of any new equipment. The managing director said his staff were very positive about new technology. He recently took three craftsmen with him to a trade exhibition in the United Kingdom to expose them to new technological ideas.

The Stet craftsman who undertook CAD/CAM training reported that the training he received had been good and well-structured. He said that at first he had been apprehensive about the changes involved in his work but in the long run he believes it will make his work easier besides giving him a knowledge of computers and additional skills. He now feels safer doing work on complicated moulds since the system avoids mistakes.

Testing of hypotheses

1. Past Record
   The company has a good record of adopting the most up-to-date equipment. The Managing Director attends as many trade shows as possible to keep abreast of developments

2. Flexible Labour Use
   The labour force is regarded as being very adaptable and receptive to new technology. Workforce skills are being upgraded on an ongoing basis.

3. Government Technological Support
   An IDA new industry grant was made available for 60% of the cost of new equipment. The firm regarded it as a good push toward new technology and this was one of the main reasons the company decided to innovate.

4. Personnel Recruitment
   The company does not have major problems retaining staff, nor has it had to recruit from outside to meet any skills gap. All apprentices have come from AnCO.

5. Personnel Skills
   Undoubtedly, the managing director's drive and marketing skills have been essential to the success of the company.

6. Importance of Skill/Personnel Groups
   Nearly all company personnel are toolmakers or toolmaker apprentices, so no comparisons can be made.

7. Skill Enhancement
   There has been an increase in the skill level of several

draughtsmen and one who has been trained to use the CAD system.

8. Proportion of highly skilled manpower to total workforce
Nearly all Stet Ltd. personnel are highly trained craftsmen or apprentices. In Techno Ltd. the personnel are highly skilled draughtsmen. A student recruited to write software is a university graduate. Another graduate is being recuited for R & D projects.

9. Government Support of Training
All company apprentices have come from AnCO and attend courses in Sligo in their second and third years. The graduate writing software was placed and subsidised under the Young Scientists and Technologists Programme.

10. Links with Education/Training Institutions
The company has benefitted from a lecturer in robotics from University College Dublin and an official from the National Board for Science and Technology. CNC training has been supplied by Sligo Regional College which also trains apprentices on block release.

11. Links with Foreign Firms
A West German customer financially supported the purchase of equipment and software. Bayer Ltd. in West Germany have provided technical advice.

12. Diffusion
There is little evidence of diffusion of skills to subcontracting firms or customers.

13. Worker Participation
There is no bargaining or joint decision-making. Management makes the decisions about new equipment, etc. and passes the information down in advance.

ARDMORE ENGINEERING LIMITED

Company profile

Ardmore Engineering Ltd. is an Irish-owned manufacturer of precision engineering products, established in 1978 and now located on the Liberties Industrial Estate in Dublin. It also produces precision sheetmetal such as computer cabinet products and is considering diversification into plastic components. About 200 different products are made by the company with an output of 10,000 pieces a month.

The business is run by two brothers, while a third works within the firm. It was founded by one of the three who bought a lathe and put it in his backshed. Work built up and eventually in 1981 the company moved to the industrial park. By 1984, it moved again to newer and bigger premises in the park. It has developed contacts with customers at the top end of the market, such as IBM, Digital Equipment and Dataproducts Ltd. It was recently awarded IBM's Quality Control Award (European Division). In 1984 it was runner-up in the Industrial Development Authority's "Small Company of the Year Award." In 1983, the company received a European Social Fund Grant for 1983-1986 to train existing and new personnel. The company currently has a staff of 26: three managers and supervisors, two in administration, eight craftsmen and 13 operators.

Nobody in the company is engaged solely in research and development. It is not required as all specifications for company products are given by customers. The directors however review trade literature and visit trade fairs to watch for future developments.

Innovation

The innovation in this case study is the introduction of CNC equipment, comprising four CNC milling machines and one CNC lathe. Ardmore has purchased one CNC machine a year in recent years, each costing IR £45,000. The company studied the equipment available at an AnCO Training Centre before it decided to go ahead buying the CNC equipment with the aim of keeping production costs down in the highly competitive precision engineering market. One of the company's customers hopes that its costs will be reduced 10% over the next five years and Ardmore finds that it can pass on to its customers savings resulting from the CNC equipment. The company finds it is producing more, although its sales have not increased dramatically. Passing along savings is regarded as necessary to meet competition from European firms with excess capacity.

Support for Innovation

The Industrial Development Authority (IDA) gave a 45% grant toward Ardmore's equipment purchase and the company is working very closely with the IDA in examining how business may develop over the next five years. "IDA has helped us make a plan setting out what we can do," the management said. IDA has also selected the company for "special company development."

In the past Ardmore had difficulty attracting the right type of skilled employee. But during the recent recession in Ireland, it recruited three highly skilled persons with relative ease. The company took several persons from AnCO and trained some itself. Four people, mainly craftspeople, were selected from within the company and were trained to use the CNC equipment. The company did not consider external recruitment at that time as it did not believe that there were enough people in Ireland with the required skills. "There was only a handful of programmers here then, so there was no choice", the company said. Now the company has no difficulty in retaining its staff.

Manpower Use & Training Programmes

The company has a stated commitment to training as it believes there is a connection between training and company prosperity. Most training within the company is operator-type training linked to the requirements of customers. Customer demands are very stringent, such as a requirement for 100% defect-free production and delivery limits of plus or minus a day in the case of components that take a month to produce. Operator training also concentrates on safety, maintenance of equipment and quality control.

Specialised training involves sending apprentices to day or block release classes at Bolton Street College of Technology; having equipment suppliers provide training in their products; or hiring expertise as is required. For instance, a supplier organised five-day in-house training courses each time a new CNC machine was introduced at Ardmore. The latest machine is a CNC lathe with its own diagnostic system. A training programme was organised specifically for this system. The company has found, however, that even with formal training it takes up to six months before a person is proficient on the CNC machines. Persons coming off the courses are able to perform most jobs but only very slowly.

Some token training for apprentices is carried on in-house if an apprentice asks for help in mathematics or workshop theory. In these cases, the company asks an engineer it knows to come in on a

Saturday morning to give "grinds" to the apprentices. There is no formal evaluation of training --"being a small company, we do not have the structures." The training programmes are reviewed only if a weakness becomes apparent. General assessments, however, are made during and after a training programme. There was daily evaluation of training in the programmes arranged by the CNC manufacturers.

There is no separate budget for training. There is only one overall company budget. The company found the CNC training was the most expensive they had ever carried out because of the low production level of trainees during their six-month learning period. But the training has increased skill levels and proficiency should increase as the CNC machines become easier to operate and programme.

There is job rotation at the operator level, but not among craftsmen. There is no formal work or method study. Work is monitored on an ongoing basis.

Worker Participation

The company is not unionised and no collective bargaining agreements were made for the introduction of CNC equipment. "It really didn't arise," the company says, "because we have a very flexible staff who understand the need for new developments in technology." The directors believe that new equipment has never threatened people's jobs but has, in fact, made these more secure by ensuring that the company is more efficient than some of its competitors.

Meetings between staff and management are held and staff are informed well in advance of plans to introduce new equipment. When new equipment arrives,"there is an air of excitement" as shopfloor people are encouraged to examine it.

Testing of Hypotheses

None was carried out in this case study.

CROWN AUTOMATION (IRL) LTD

Company profile

Crown Control (Irl) Ltd.in Galway, originally established in 1960, is now a wholly-owned subsidiary of Crown Control Corporation, New Bremen, Ohio, USA, which bought the Irish company from the Steinbock Corporation of America in 1968.

The company manufactures a wide range of pallet lifting equipment and material-handling trucks. The most important line is a small hand pallet lifter which is exported worldwide. Other products are a powered pallet truck, an electric forklift truck and a number of electric stacker trucks.

The innovation studied in this case is the introduction of two robotic welding stations which occurred between June and November 1984. Robotic paint-spraying was introduced in early 1985 and since this study was concluded a further robotic welding station has been introduced.

In the year prior to March 1984, the subsidiary's turnover was IR £5.8 million and it had 260 employees.

Technical Innovation

The firm, from visits to competitors and general industrial intelligence, was aware that its production time for the basic hand pallet truck of 7.1 hours was uncompetitive. Its two main competitors in Sweden and France had shorter production times of 3.25 hours and 2.75 hours respectively. The objective was to reduce manufacturing time nearer that of its competitors. This would allow the firm to hold and improve its share of the market.

The company's internal margins were being progressively squeezed. External price increases were not possible. Internal margins thus had to be improved. New technology was seen as essential if profit margins were not to disappear within five years. Initial project calculations were made without taking into account State incentives and innovations were considered feasible. Delays were considered inadvisable. Innovations, the firm felt, must take place while the firm was prospering and not under pressure either financially or from the market situation or from industrial relations. Possible State grants were considered as a bonus.

The whole manufacturing system was examined in 1983 and robotic welding was quickly identified as a major possible improvement in the construction of the hand pallet truck. The high production volume of these trucks would warrant the cost of robotic welding, whereas the low volume of other truck ranges would not.

Welding robotics could not be introduced in isolation from other changes in machinery. This would involve financial outlay of the same order as that of the robot stations themselves. Most importantly, precision bending and metal forming were required to permit robotic welding. The quality of steel supplied also became a critical factor. The human welder could allow for variations in quality but the robot could not. The payback period for the investment was calculated at two years. The robotics would be written off over four years and although they have an effective life of seven years, it was felt that they would be scrapped at the end of the fourth year.

The introduction of the robotics in 1984 and 1985 took place alongside other plant modernisation, such as CNC machinery and robotic paint spraying which improves working conditions, reduces paint costs and increases efficiency and productivity. Fast oven-baked drying also improves quality and saves floor space.

Production time for the pallet truck fell from 7.1 hours to six hours in mid-1985 and was expected to reach five hours by the end of 1985. With a sub-assembly area due for modernisation, the production time is expected to drop to four hours by mid-1986.

Plans for the next 18 months call for the introduction of production control aimed at lowering stock levels and increasing the use of robotics. The firm contends that manufacturing is an integrated process which must be modernised as an entire system rather than in terms of units of production.

Crown Ltd. is planning to add three or four additional staff in mid-1986 and is negotiating with IDA for grants for research on how to re-design American products for the European market. There is a move, however, by the parent company to concentrate R & D in West Germany because of greater availability of engineers with experience in robotics and modern technology.

New technologies which Crown Ltd. sees as likely in the near future are pick and place robots and user-friendly CNC and CAD machines.

Support for Innovation

The firm decided against the use of consultants because it was considered that they were not familiar with the company's business and Irish consultants did not know what machinery was available. Disappointing contacts were made with the Irish agents for robotic firms, so the firm went straight to the manufacturing subsidiary in the United Kingdom of a Swedish firm. The UK firm was asked to produce trial pieces and the components were tested. Crown Ltd. then designed the overall system into which the robotics were fitted. A visit was made to a Swedish pallet factory to gather ideas and a European sales representative was hired whose ideas helped frame the innovation process.

As mentioned above, the company's calculations were made net of government grants, these being included only in the final figures. The major grants were a 35% grant for capital equipment made by IDA and grants for training by AnCO. The capital grant was 35% of the IR £1.5 million which the new equipment cost.

The firm feels it has a high degree of autonomy from its parent, a fact that motivates it to innovate. It operates its own marketing and sales organisation from Galway and its purchases of machinery have been financed from its own retained earnings. It is treated as a profit centre separate from the parent company but is aware that if it does not perform it can easily be disposed of by the American company.

Many basic skills were available in-house for the new operations. The workforce also was adaptable and flexible with good informal communications, job rotation and an awareness of the company objectives.

The only additional person hired was a qualified technician to maintain the equipment. He liaises with ESAB, the supplier of the robotics, and is able to diagnose problems. He works more with the Swedish parent company than with the UK subsidiary because of its strong R & D.

The firm has used the Institute for Industrial Research and Standards for testing metal properties and machining quality. At the moment, the hand pallet's hydraulic unit is being redesigned. This is a two-year project which will reduce costs. Aluminium casting, instead of steel, is being examined as a possibility.

Parent company support tends to be limited to testing facilities and emergency help. Suppliers are helpful in providing equipment

and components. Support from higher education is nearly non-existent. The local Regional Training Centre ran one CNC evening course but that is all. There is no involvement with the local university and graduates are not in great evidence in the firm. This is partly due to the policy of internal promotion. The firm has, however, been exploring the possibility of co-operation with the National Institute of Higher Education in Limerick.

The company feels that "companies should stand on their own feet." It makes its investment decisions net of any grants that can be claimed. Government employment incentives and support are not used as a matter of principle, because of their bureaucratic nature. Company officials criticise the Irish tax system for its complexity which they say does not aid competition with European and American rivals.

Manpower Use

The attitude of the workforce to the new technology was mixed. Some predicted an end to overtime and an increase in redundancies. Management recognised the need to communicate with the staff. Talks with groups of up to 15 workers were organised throughout the factory to discuss the new equipment. Each group selected included at least one voice against its introduction. This ensured that opposition would not occur in one group only but that every group would hear arguments against the change as well as management's rationale for it.

Well in advance videos were shown of robotic welding elsewhere and the savings in time were explained so there would be no surprises. The union does not have a role in the planning of skill training although its agreement is always obtained both for changes to result from new technology as well as for necessary training programmes. The management held a series of initial meetings with the district secretary of the AUEW and company shop stewards to obtain their general co-operation and agreement.

Selection of workers to train and operate the new equipment was made by management and then agreed upon by the unions. Young adaptable workers were chosen. Older workers have meanwhile largely adapted to the changes. (The average age in the firm is about 40 years). Selection of workers for related jobs now has moved toward open advertisement of the posts.

The union's main concern in negotiations was the possibility of redundancy. Once it was clear that the company was going to guarantee that there would be no redundancies, the union's

co-operation was positive. In all, the union was satisfied with the training received and the way the new equipment was introduced. It agreed it would make no wage claims while the investment was underway. If the union had actively opposed innovation, the company probably would not have proceeded.

The commitment of supervisors to the new technology also was obtained by having them take part in examining departmental needs and then having them place orders for purchase.

Training Programmes

The firm's main product is an inexpensive unit with low profit margins. It is very labour intensive even with the new robotics and CNC. Thus the firm feels training costs should be kept low. It was determined that training would take place well ahead of the introduction of the new technology. A European Social Fund grant, however, allowed the production manager to argue more forcefully for fuller training than was planned and thus the training purchased from ESAB, the robotics manufacturer, was increased from two to four weeks.

CNC training was undertaken in the UK by the supplier, Cincinnati Milacron, and by AnCO in its Dublin training centre. The AnCO training was mostly in programming techniques.

Three robotics supervisors spent one week with the UK supplier and four weeks with AnCO, the latter being spaced out over nine months. All aspects of robotic welding programming were examined and this knowledge was quickly put to use in changing original programmes to meet the firm's needs. A craftsperson in robotics spent one week in the UK and two weeks training in-house, mainly studying maintenance. The operators spent one week in the UK, two weeks with the supplier and eight weeks on-the-job.

The company now feels it can train people as new robots are introduced but it feels its primary concern is production, not training. Thus if training is carried out by the supplier it will be done as planned, on time and without interruption.

At the present, all robotic welders are being given training in programming so that the process is understood. Eventually they should be able to do it alone, adjusting welding requirements to variations in materials. The skills of these welders are changing radically. Robots keep a more even height and speed of laying a weld than any welder can. At the moment, the welders identify current drop or feed drop and check the quality of the weld. They

can touch up robot welds if faults occur. But the welding craft is vanishing and the operative is becoming more of a quality control operator. Welders are currently changed back and forth between robotic welding and hand welding to ensure that old skills are not lost.

The need for human backup will however be less as robotic vision sensors are introduced on future robots. The introduction of special purpose equipment throughout the plant is in fact having a major de-skilling effect, with semi-skilled jobs also disappearing.

Recognised training instructors exist in all four departments: material preparation, machine shop, assembly and finishing/dispatch. Training has been almost totally on-the-job. All instructors have been on AnCO courses. The firm budgets a certain amount each year for training, the amount depending on need. Last year's budget was high due to the amount of new equipment. Training evaluation is carried out by supervisors and there are no formal mechanisms for judging it. The company has been given a very high training rating by AnCO.

As for employee turnover, the company had a very low rate in the prosperous 1970s. Today turnover has almost come to a halt due to the present economic climate. Thus a diffusion of skills by this means is almost non-existent.

Some work is currently subcontracted outside due to insufficient capacity in the plant. But as space is made available through a factory extension, this work will be taken back.

At the moment, the firm is assisting another company which has tooling difficulties. This in fact goes against company policy and is not seen as a long-term commitment.

Testing of Hypotheses

1. Past Record
   From 1968 to 1983 Crown could not be said to have been innovative. It had made constant minor modifications in product and processing, following a pattern widely practiced in the industry. Little in its history indicated it would commit itself to innovation as it has.

2. Flexible Labour Use
   Workforce, union and management flexibility were essential elements in the changes. Union commitment was particularly important.

3. Government Technological Support
Government support played a negligible role in execution of the innovation. ESF grants did allow a more comprehensive training programme. Use also was made of AnCO's programming facilities. While marginal to the firm's success, they were appreciated.

4. Personnel Recruitment
The company made a conscious decision to rely on its own staff and their retraining. Technical knowledge had to be built up from zero. Suppliers were the most important external source for the successful initial installation. Maintenance now is highly dependent on a single person who has learned sufficient diagnostics to cope with the robots.

5. Personnel Skills
The company operates a closed shop with a largely middle-aged workforce. It was realised that welding as a skill would no longer be as important as previously. Sophisticated personnel and negotiating skills were needed to negotiate with the workforce the introduction of robotics.

6. Importance of Skill/Personnel Groups
Two factors strongly influenced the introduction of the innovation: Management's commitment and, on the technical side, the presence of a staff member capable of assimilating micro-electronic knowledge.

7. Skill Enhancement
There has been a movement away from craft and manual skills toward technical/microelectronic-based skills. De-skilling of welding has been most evident and will continue as robotic vision and sensors are introduced. New skills acquired have been programming on the part of welders and the development of quality control skills.

8. Proportion of highly skilled manpower to total workforce
By Irish standards the firm was exceptional before the innovations for the quality of its management and production organisation although it was in no way "high tech." The difference between this firm and non-innovative Irish firms lies most strongly in the area of management rather than in technological expertise.

9. Government Support of Training
External Irish support was negligible except for a programming course provided by AnCO.

10. Links with Education/Training Institutions
No major contact was established with this sector.

11. Links with Foreign Firms
The firm had no support from the American parent company as the parent did not possess robotics.

12. Diffusion
There has been little or no diffusion of skills, nor is there likely to be any in future.

13. Worker Participation
Union co-operation was important but it played a largely passive role in the introduction of robotics.

NORCO LIMITED

Company Profile

Norco Limited is jointly owned by Waterford Glass Ltd., and Norco Inc., USA. It was established in August 1973 and is located on Waterford's Industrial Estate. The company manufactures mechanical actuators and high precision engineering products. It has expanded considerably with the introduction of Numerical Control (NC) and Computerised Numerical Control (CNC) machinery and has moved toward making products for the aerospace industry. It also makes mechanical products for the paper industry. Its turnover of IR £235,000 in 1977 was up to IR £2.2 million in 1985. Exports rose in the same period from 80% to 98% of output. Most exports go to EEC, with the UK the major customer. The rest goes to the USA (via the American parent company), to New Zealand and to Japan (via Norco in Japan).

The increase in turnover and the move toward more sophisticated products resulted from an increase in investment in fixed assets, ranging from IR £38,000 in 1977 to IR £890,000 in 1984. There was a combination of leasing of CNC machinery with outright purchases. The increase in productivity from this investment in CNC has not been measured directly but the firm increased its profit margins from 5% in 1977 to 20% in 1984 while keeping to inflation-adjusted prices.

The company does little subcontracting. What there is is with foreign companies as Irish firms are considered unable to meet requirements.

The local technical college is shown around the factory from time to time but that is the extent of skill diffusion.

Technical Innovations

This study examines the introduction of NC and CNC machinery from 1977 on. The machinery introduced was:

a) NC horizontal machining centre
b) 2 CNC (2X) turning centres
c) Vertical CNC machining centre (4X)
d) 3X turning centre
e) CNC vertical machining centre (4X)
f) CNC milling machine

The basic decision to innovate came from recognition that this was the future of the industry. Margins were being squeezed and the competitiveness of the firm was regarded as being dependent on innovation.

The company feels no need for long-term technological analysis. It monitors new developments and is familiar with what is coming, so effects on manpower are assessed when the changes are closer to reality. The company is now assessing the introduction of computer-aided draughting and computer-aided manufacture. Production control is now being computerised which will allow more extensive work study. There is strong financial pressure not to have the CNC machines idle and this has resulted in increased emphasis on planning, particularly production planning.

With the introduction of more sophisticated technology and products, the firm has spent more on R & D. This has gone up 20%. There are no designated R & D specialists and no specialised equipment. Prototype work has been performed on existing equipment with specific people assigned to the research.

Quality control has changed radically with the new CNC technology. The company has moved away from human inspection in which scrapping depended on the operator's eye and experience. With the use of CNC machinery, scrapping rates have fallen from 10 % to 2% as operators can now set detailed instructions.

Support for Innovation

Once the decision was taken, the key to successful introduction of the NC/CNC machinery was recruitment abroad of a person with the necessary practical and managerial experience of the equipment. The suppliers were valuable in supplying literature and on-site explanations.

Capital grants of 40% from IDA and AnCO grants were used but were not a crucial factor in the decision. The IDA grant made the project more viable but competitive pressures would have forced innovation in any case. The AnCO training subsidies were also useful but AnCO expertise was regarded as being behind the state-of-the-art.

It was also felt that AnCO did not understand, in its grant structure, the need for updating skill training as more sophisticated equipment was introduced.

Financial support from banks was forthcoming and was regarded as important.

Manpower Use

The lack of manpower skilled in operating the CNC machines was the first major handicap. These skills had to be provided by the firm itself. AnCO was seen as too far behind to be of real help. The lack of highly skilled CNC personnel continues as a problem.

Given the effort the company has put into training its employees, it fears losing them should economic conditions improve. It has no philosophy on redundancy other than "last in - first out." General policy is to promote from within. Staff pass from the shopfloor to quality control, to the design office, to production engineer and other supervisory levels. This is being made easier since the firm is now recruiting technical college people for the shopfloor rather than hiring craft apprentices.

The nature of the job has changed. Manual skills have decreased substantially while there is more need for theoretical knowledge to operate the machines. The new CNC machinery is producing a further de-skilling of operators. Old equipment required that operators optimise the setting after the machine was programmed. The new equipment functions faster than the operators can set it.

With new products and more CNC machinery, the firm has moved to a double-shift system operating the CNC machinery. It is expected that the firm may eventually move to a three-shift system to increase its rate of return on the high cost of the capital equipment.

The move to a shift system and to more sophisticated products increases the demand for skilled labour with manual as well as programming skills. The company insists that all fully trained operatives use manual machines as well as CNC machines. Each operator can, but does not as yet, programme his own machine. For the moment this is done by the supervisors. Flexibility is regarded as important so the workforce can be moved around the factory as incoming product orders require.

Neither the workers nor the trade unions felt threatened by the new equipment since their numbers are growing and their earning potential has not been eroded. There is, indeed, a feeling of privilege in working with the CNC machinery since it is used largely by more skilled, longer-serving members of the workforce.

Training

Initially, the company sought CNC experts by advertising in the UK and through the Irish National Manpower Service. It managed to recruit some people from a company in Athlone which was bankrupt but in the end it was forced to accept that it would have to train its own unskilled people. It preferred to recruit technicians from the local regional technical college who would have good theoretical knowledge and could be given practical training. Craft apprenticeship was by-passed by the firm on the grounds it was too time-consuming and did not produce the proper type of technically-oriented employee. Suppliers provided information and help when they carried out initial training in the factory.

In summary, the most important skills came initially from the person recruited in the UK who is now manufacturing manager. The weight of training fell on the company. Outside institutions, whether from higher education or the State sector, had little influence.

The first training programme (September 1979 to August 1982) had targets to

a) Transfer skills from skilled supervisory/technician level to existing, mainly unskilled operatives
b) Train new unskilled employees
c) Train ancillary staff to replace American personnel
d) Train new ancillary staff

Operatives with little or no skill were to be comprehensively trained in conventional skills. Only the technical and supervisory staff, trained in the US or the UK, possessed the full depth of skills. It was expected that 49 extra staff would be trained (41 production, 9 ancillary). As things developed, the actual change in employment between 1979 and 1982 was as follows:

	1979	1982
Managers/Supervisors	3	7
Professional, admin, Sales	10	8
Technologists/Technicians	8	7
Craftspersons/skilled workers	-	-
Production Operatives	18	27
Other	-	1

Under the first programme, millers received 22.5 weeks' training over 45.75 weeks. Grinders received 21 weeks training over 42.75 weeks. The in-house training was about 15 weeks (the rest being off-the-job) and was carried out by four engineers and three

technically-skilled employees. External training was carried out by six institutions, mainly a university 80 miles away.

The first training programme was not completed for three reasons:

1. The company originally expected an expansion of both its business and workforce based on a wider sale of mechanical actuators. This was hit by recession. The workforce was not expanded and there was no need for more training.

2. The versatility shown by skilled personnel in coping with the new products and the new CNC equipment was unexpected.

3. With the recession there was no need for new people, while at the same time production actually increased. The consequence was that staff could not be easily released for training.

The second training programme for 1983-1986 has concentrated much more on CNC machining skills. The company feels it must have adequate skilled staff to make direct inroads into the European commercial aircraft industry, as well as the American marine industry, oil drilling rig industry and the paper and chemical industries. A move to higher skills would make the Irish company more compatible with the American parent company which is heavily involved in the military and aircraft sectors.

CNC production operatives are being trained on-the-job by the Production Manager with an AnCO expert seconded to the company. The training is receiving European Social Fund aid, as did the first programme. The sum of IR £180,000 has been authorised but modifications in the training programme may cut that to £100,000.

Sixty-three percent of the factory staff (38 of 60 people) are being trained. These include two new engineers and one existing engineer; one new quality control person; two existing draughtsmen; seven new and 25 old production operatives.

Training includes two main programmes. One is for CNC setter operators lasting 18 weeks at a cost of £2,815 a person, and the other is for CNC setting/programming operators for 24 weeks at similar high cost. Conventional equipment training is being carried out on-the-job by the foreman who himself will take an AnCO trainer's course along with the production manager. The maintenance engineer is being sent to Cincinnati Milacron in the UK for experience in rectifying and preventing breakdowns.

All persons receiving CNC training will be shown how to programme. The ability of operatives to make tool and programme changes is seen as essential for maximum flexibility when the shop is working at full capacity.

Testing of Hypotheses

1. Past Record
   Norco Limited has been in operation only 12 years. Its record from the start has indicated a propensity to innovate.

2. Flexible Labour Use
   The company demands and trains for total shopfloor flexibility. There is a notable absence of craftpersons although the workforce is highly skilled.

3. Government Technological Support
   IDA grants were useful for capital purchases. R & D grants were not used but may be in the future. AnCO training was considered backward. Secondment of an AnCO trainer for in-house training was considered valuable.

4. Personnel Recruitment
   The company experienced major difficulty in recruiting CNC personnel. It was a handicap to have to train their own people from scratch.

5. Personnel Skills
   Personnel skills were not considered a major factor in a firm which had introduced NC machinery early and was introducing more sophisticated CNC machines.

6. Importance of Skill/Personnel Groups
   The company considers itself lucky to have recruited its manufacturing manager from the UK which coincided with the introduction of the CNC equipment. He was critical to its success.

7. Skill Enhancement
   Conventional skills are maintained by all CNC operators so they can also use conventional machinery. The CNC machinery is becoming easier to operate as it becomes more sophisticated. Operators are changing from manual skills to the more intellectual skill of programming.

8. Proportion of highly skilled manpower to total workforce
   In comparison with other Irish firms, manpower skills are very high particularly among operatives.

9. Government Support of Training
   High-tech education and training in Ireland were felt to be

very weak, so the firm relied on its own resources although a university and AnCO played support roles.

10. Links with Education/Training Institutions
Norco receives no effective technical support from higher education although a small amount of training is done. The company feels it has little influence on the content of courses at the local regional technical college.

11. Links with Foreign Firms
Norco has close ties with its American parent. Support can be obtained from there but is little used. The Irish company wishes to be so autonomous that it would not be affected by the parent company closing down. It relies on Cincinnati Milacron in the UK for CNC maintenance.

12. Diffusion
There is little or no diffusion of skills.

13. Worker Participation
Neither trade unions nor workers' representatives actively participate in decision-making.

BRAUN (IRELAND) LIMITED

Company Profile

Braun (Irl) Ltd. is a subsidiary of Braun GmbH, the large German multinational which is part of the Gillette Corporation of the United States. It is based in Carlow, 50 miles southwest of Dublin. It employs some 1,100 people and provides about half the manufacturing employment in the town.

The innovation examined in this study is the design and implementation of a real-time digital control system for a temperature testing machine. The system reflects a major trend in the factory away from mechanically and pneumatically controlled systems toward micro-electronic controls. This has major implications for the training of shop floor and maintenance personnel.

Braun (Irl) Ltd. opened in 1974 with 35 employees. These rose to 211 in 1975 and jumped rapidly to reach 1,050 in 1981. Thereafter employment stabilised around 1,100. The company produces electric razor foils, calculators, cigarette lighters, hairdryers and stylers. Sales in nominal terms were 1983 - IR £23.26 million; 1984 - IR £28.38 million; 1985 - IR £34.7 million.

Sourcing of raw materials in Ireland is about 10 percent. It is hoped that this may reach 20% in the next few years. The main problems in obtaining Irish materials are availability, the delivery criteria and quality.

Delivery in fact will become more important as the firm moves to a "Just in Time" production basis, which already is putting increasing strain on the Quality Control Section in dealing with smaller, more frequent deliveries.

Investment at Braun Ltd. takes place under three main headings: basic infrastructure and plant; new products; and in concepts, ideas and control engineering. The overall investment plan from 1983 onwards has been: 1983 - IR £418,000; 1984 - IR £2,620,000; 1985 - IR £2,219,000; 1986 - IR £6,000,000. From 1986 to 1989 the plan calls for IR £17,000,000 annually.

Company investment is directed toward:

1. Relieving office congestion
2. Expanding factory floor space to permit better flow of materials
3. General housekeeping
4. Introduction of new products
5. Introduction of a totally automated warehouse.

Investment in R & D was between £200,000 and £300,000 in 1984 and was about £400,000 in 1985.

The firm subcontracts boxes and metal trays inside Ireland but sub-contracts for more sophisticated plastics and moulds go abroad. Before using an Irish supplier, Braun visits the supplier to look at his production and quality control systems. The subcontractors' long-term profitability is also examined to ensure that he can continue to supply over a long period.

Technical Innovation

All product development takes place in West Germany, from where support in R & D can be obtained for process changes. Support also comes from Gillette Group research facilities in London and from the Institute for Industrial Research and Standards (IIRS).

Within the Carlow plant the drive toward process improvement is organised through six "Cost Savings Groups" of personnel from different departments. These groups are expected to provide cross-fertilisation of ideas and more effective design and implementation of projects. At any one time, there are 30-40 savings projects underway. The theoretical flow of a major project is shown in Figure 1 at the end of this study.

In planning automation company policy is that the labour content of production should be reduced by 2 percent per year. To meet the short lifetime of its products, often only two years, the company is moving toward a form of flexible automation.

Less importantly, there is a "suggestion scheme" which is open to all. It generates about 50 suggestions a year with awards of up to £1,000 for ideas implemented.

The objectives of the Industrial Engineering Department and the Manufacturing Engineering Department are to improve production

line efficiency. Most work centres around good machine design and its improvement. There is however a skill shortage in machine design because of a need to combine practical knowledge of mechanical/pneumatic machinery with more theoretical engineering skills.

In overcoming design problems, consultation takes place with setters and fitters. This is for practical reasons (such as ease and speed of setting up and monitoring machinery) rather than for industrial relations reasons.

The innovation for this case study was the design and implementation of a real-time digital control system for a temperature testing machine. The machine had to carry out a final temperature test on some 10,000 gas-powered hair curlers made in the factory every day.

This temperature testing machine was designed in Carlow by a member of the engineering department in consultation with the design manager and toolmakers. The electronic control circuit and software were designed by a student from a university department. The machine was constructed in the Carlow toolroom by company toolmakers and was wired by company electricians. The only part not made in Carlow was a control box unit which was contracted out to the Braun plant in Germany.

The new machine brought savings of £71,500 annually to the company. Part of this came by saving eight work posts on the redesigned production line. Differences between the old and the new methods saved some 170 minutes per 100 units.

This innovation is one of many Braun Ltd. cost-cutting exercises, carried out to make its products sufficiently cheap to deter other firms from entering the market.

It indicates the variety of skills required by the firm: electronics, design engineering, machine design, costing, toolroom work, etc. It was the first occasion for microprocessors to be used in the factory. A full-time electronics engineer and a new electronics department meanwhile have replaced the use of outside electronics expertise.

Microelectronics is demanding major changes in skill requirements. The skills of the maintenance people are being directed toward diagnostics. There is a trend toward using replacable units rather than carrying out traditional repairs.

Mould technology is also changing with radical consequences for skill requirements. Moulds have moved from a "building up and matching" technique to one based on standardised clamping. This is making the setter's old skills obsolete and replacing them with simpler methods. Down time has dropped from 30 minutes to 10 minutes.

Support for Innovation

The firm relies heavily on exchanges of ideas with Braun GmbH and Gillette. It visits other Braun factories as well as trade exhibitions in search of new ideas. It has made use of the IDA's 50% research and development grants to have a £65,000 project undertaken by the IIRS.

The firm found it difficult to obtain effective support from the higher education sector because its needs were specific and urgent. Higher education could not respond.

Suppliers were found to be very helpful in training which was done in-house and recorded on video tape.

State work experience programmes have been utilised to take on people at £110 a week, the firm receiving back £60. The company employs the best of these people but the majority are not retained.

As for training, the company would have done a great deal even with State grants. The fact that half of training costs are returned to the firm has been an added benefit. The AnCO training advisor was very helpful and on-the-job training provided by AnCO was of key assistance to the firm.

Manpower Use

In January 1984, the employment structure was as follows:

Managers/Supervisors	60
Professional/Admin/Sales	67
Technologists/Technicians	58
Craftsperson/Skilled Workers	35
Production Operatives	822
Others	-
Total	1042

The firm finds it difficult to attract senior and middle management people to Carlow because of the town's small size, the difficulty for spouses to find employment there and the risk of buying houses in a town so dependent upon one employer.

The firm recruits many technicians from the local Regional Technical College.

Promotion is internal if possible. However, it is also felt that too much internal promotion can lead to stagnation.

The company recruited quality control people from a large American multinational which was closing some 25 miles away. These were well-trained and suitable. In electronics, the firm has also attracted fully-trained people from other firms. It has had no problem retaining skilled personnel since 1981 but that could change if there is an economic upturn.

The monitoring of technical change is carried out by attending exhibitions and feedback from the German parent company.

The company operates a "last in, first out" redundancy policy agreed with the unions. Employment fluctuates as products are discontinued and new ones are introduced. The company feels however that the "first in, last out" policy is wasteful in terms of training and skills. When a product line is closed, longer-serving operatives must be moved to other lines where they displace newer operatives who are often recently trained and are then made redundant. There is a "last out, first back in" policy for rehiring redundant workers.

The company feels that innovation does not cause redundancy. While there are less jobs per unit of production, increasing production compensates for this. Cyclical changes in sales are considered far more disruptive to employment. There is no consultation with the unions or with workers on the introduction of new technology or products. This is considered unnecessary and complicating decision-making. There is, however, a good information arrangement with union officials so they are kept informed and are not surprised.

Technological changes have brought a number of issues to the surface. Production equipment in assembly is at present repaired and maintained by the company's setters and the moulding equipment is cared for by fitters and electricians. The setters are recruited from the ranks of male operatives. They have no formal engineering training or the skills and know-how to diagnose, or

repair and maintain the complex, hybrid electronics-pneumatics-mechanical technology. Production supervisors are unable to provide technical direction for setters in microelectronics.

Setters of line equipment installing the moulds are promoted from the operative level. This requires a training programme. The skills of setters are becoming broader as they become more "general practitioners". The machinery is becoming increasingly complex requiring inputs from highly skilled technicans. Thus union demarcation problems have arisen as the setters assume more technical functions.

The supervisor's role also is changing. He is forced to become more technically competent as workers under him increase their technical ability. The German system in which "supervisors" have taken courses and exams is regarded as superior to the Irish method where people have just "served their time."

This situation is being met by the company by reorganisation of working methods and through training. The present and proposed organisation is shown in Figure 2. The "present" shows the traditional heirarchy with the setter reporting to the supervisor. The proposed structure shows the "explosion" of management structure into a number of specialised "technical support" functions. This recognises the inability of supervisors to technically supervise setters as well as the problems facing the pre-production and assembly managers in coping with new technological requirements. The new structure vests responsibility for technological management in new independent groups which co-ordinate with assembly and pre-production units only at the level of the production manager.

The new responsibilities of the moulding and assembly technicians are shown in Figure 3. The technician becomes a co-ordinator (supervisor) of technically skilled craftspersons through his own superior technical abilities. The traditional supervisor has ceded his technology management function to the technician.

The even more strategic position of the technical support managers is shown in Figure 4. They have responsibility for co-ordinating new production methods with other factory functions, ranging from budgeting and capital expenditure to purchasing and quality control.

Training Programmes

Training is the other major avenue to cope with technological change. The aim is to upgrade the skills of setters and give them expert technical direction on a daily basis.

The training cycle for assembly and moulding setters is shown in Figure 5. The title of setter changes to "technician", indicating his more important role in reporting now to a "manager" rather than to a "supervisor". In the training programmes for assembly setters there is close integration between the in-house training and that of the Regional Technical College (RTC).

The two-year programme for the moulding technician is shown in Figure 6. It shows the integration of AnCO courses with internal training in the first year, and the integration of local Regional Training College courses with internal instruction in the second year. The differing paths of the two types of technician (mould setter and toolmaker) are shown. It also shows the emphasis placed on assessment and examination by the firm. This contrasts with the craft apprenticeship system which has only a time-serving requirement.

Craftspersons (trades people) such as fitters, electricians and toolmakers receive formal union-recognised training. However, electronics craftsmen go through a RTC/in-house programme and obtain certificates as a technician rather than as a craftsperson. Electronics is not recognised as a craft trade in Ireland.

Testing of Hypotheses

1. Past Record
   Current technological changes are part of a continuous factory drive to improve processing and quality and cut costs.

2. Flexible Labour Use
   Redeployment of labour within the firm is a regular feature as one product dies and another is introduced.

3. Government Technological Support
   Financial support obviously assisted the firm but it can argued that competition would have forced the company to innovate with or without grants.

4. Personnel Recruitment
   The reorganisation and training of setters and maintenance

staff will be a key factor in the future use of microelectronics.

5 & 6. Personnel Skills
The interfacing of traditional mechanical and pneumatic skills with microelectronic skills will be essential for the future profitability of Braun Ltd., as will be the use of designers' and technicians' skills in automation.

7. Skill Enhancement
New groups of skilled workers are being created, notably by retraining setters for microelectronic skills. Supervisors have lost some ground by becoming less involved with the new equipment.

8. Proportion of highly skilled manpower to total workforce
The firm does not have a particularly high ratio of research and highly skilled manpower to its total workforce nor can it be said to be highly innovative in process technology.

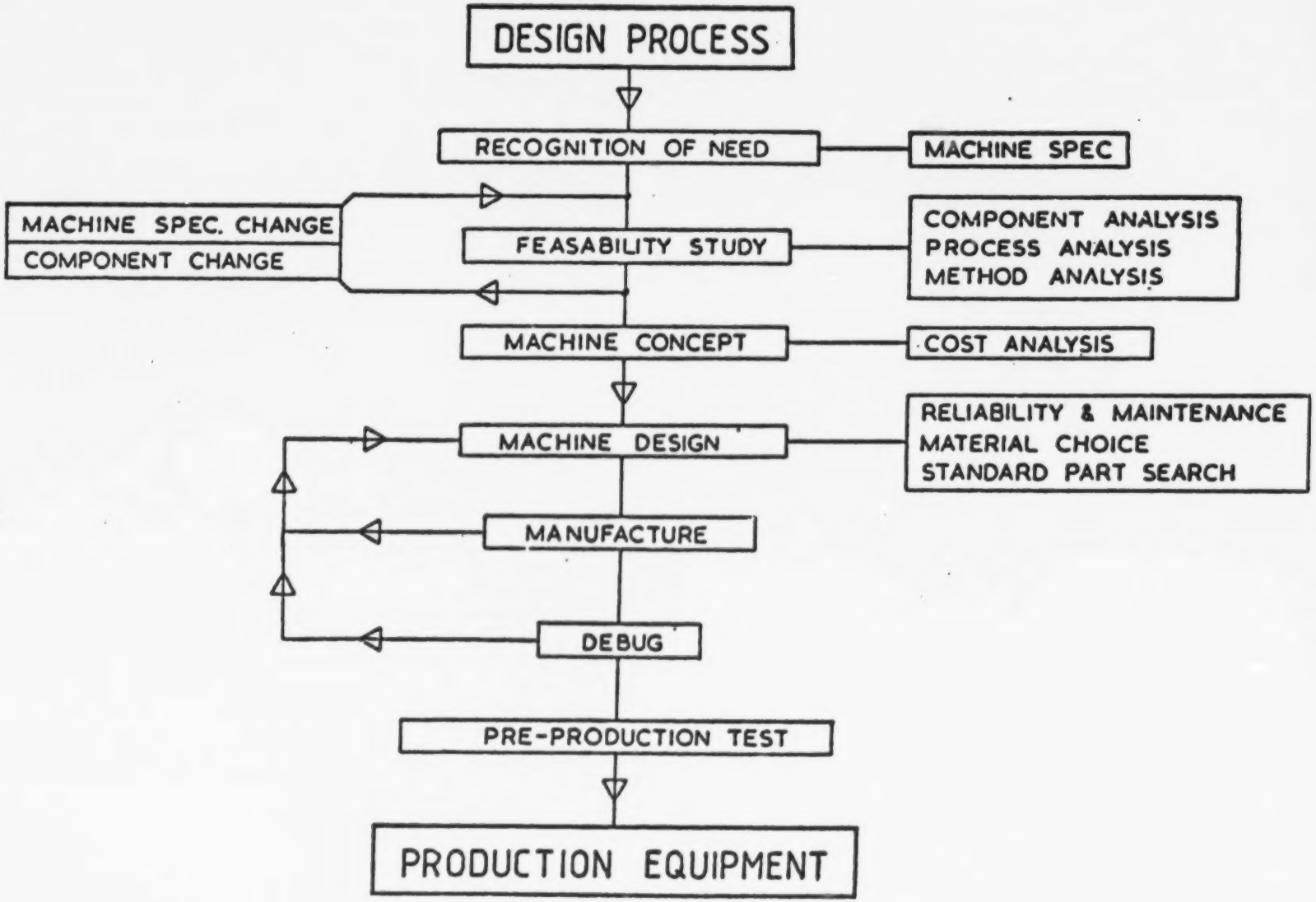
9. Government Support of Training
Government support was of limited importance to the firm. Innovation would have been undertaken regardless of government grants for R & D and training. Capital grants and tax-based leasing were more important to company profits.

10. Links with Education/Training Institutions
Interaction with higher education has been limited to courses with the local Regional Training Centre. Higher education research facilities have not been used.

11. Links with Foreign Firms
Braun's German parent has the most effect on new operations within the Irish company by the exchange of personnel, technical support and information which takes place.

12. Diffusion
The firm is not a strong diffuser of technical skills. There is some transmission of skills to subcontractors.

13. Worker Participation
Neither trade unions nor workers' representatives actively participate in decision-making. Workers' ideas, however, are invited.


DESIGN PROCESS
RECOGNITION OF NEED
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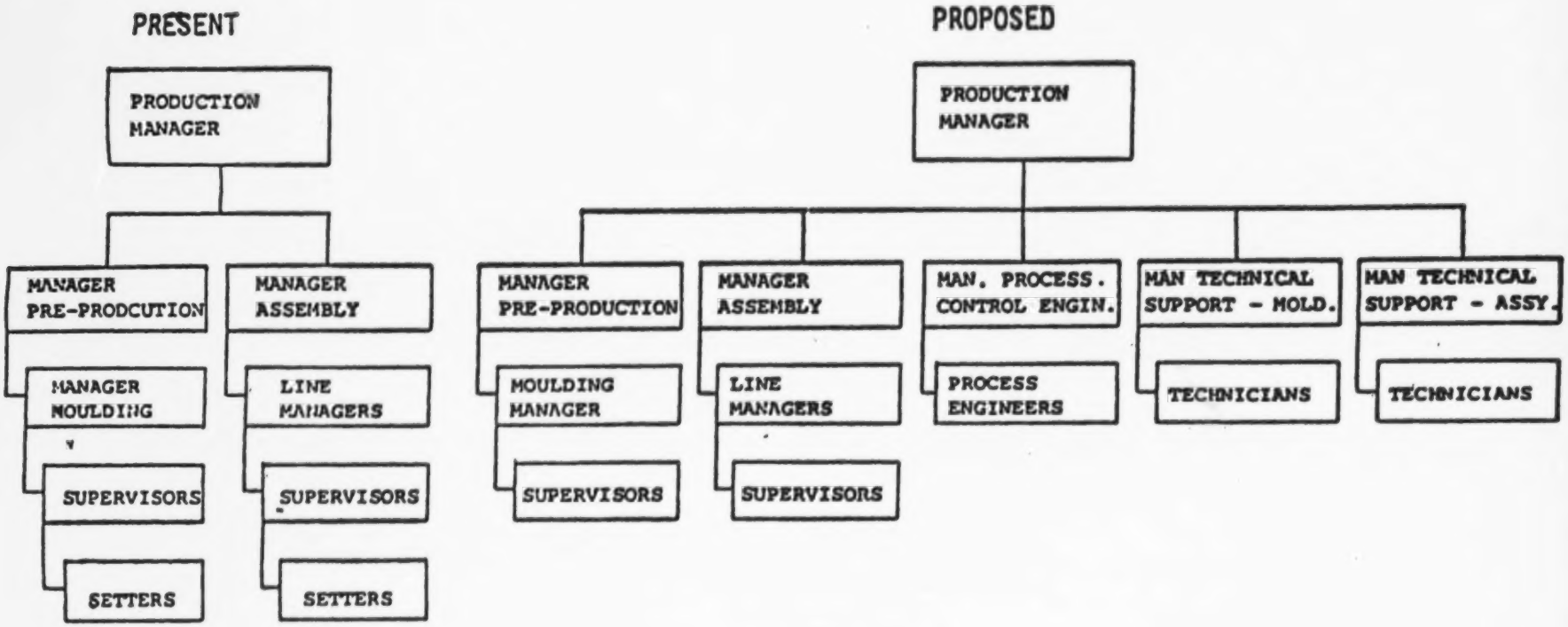
COMPONENT CHANGE
FEASABILITY STUDY
COMPONENT ANALYSIS
PROCESS ANALYSIS
METHOD ANALYSIS
MACHINE CONCEPT
COST ANALYSIS
MACHINE DESIGN
RELIABILITY & MAINTENANCE
MATERIAL CHOICE
STANDARD PART SEARCH
MANUFACTURE
DEBUG
PRE-PRODUCTION TEST
PRODUCTION EQUIPMENT

FIGURE 1

ORGANIZATION STRUCTURE



BRAUN IRELAND LIMITED

FIGURE 2

PROCESS CHART - MOULDING TECHNICIANS

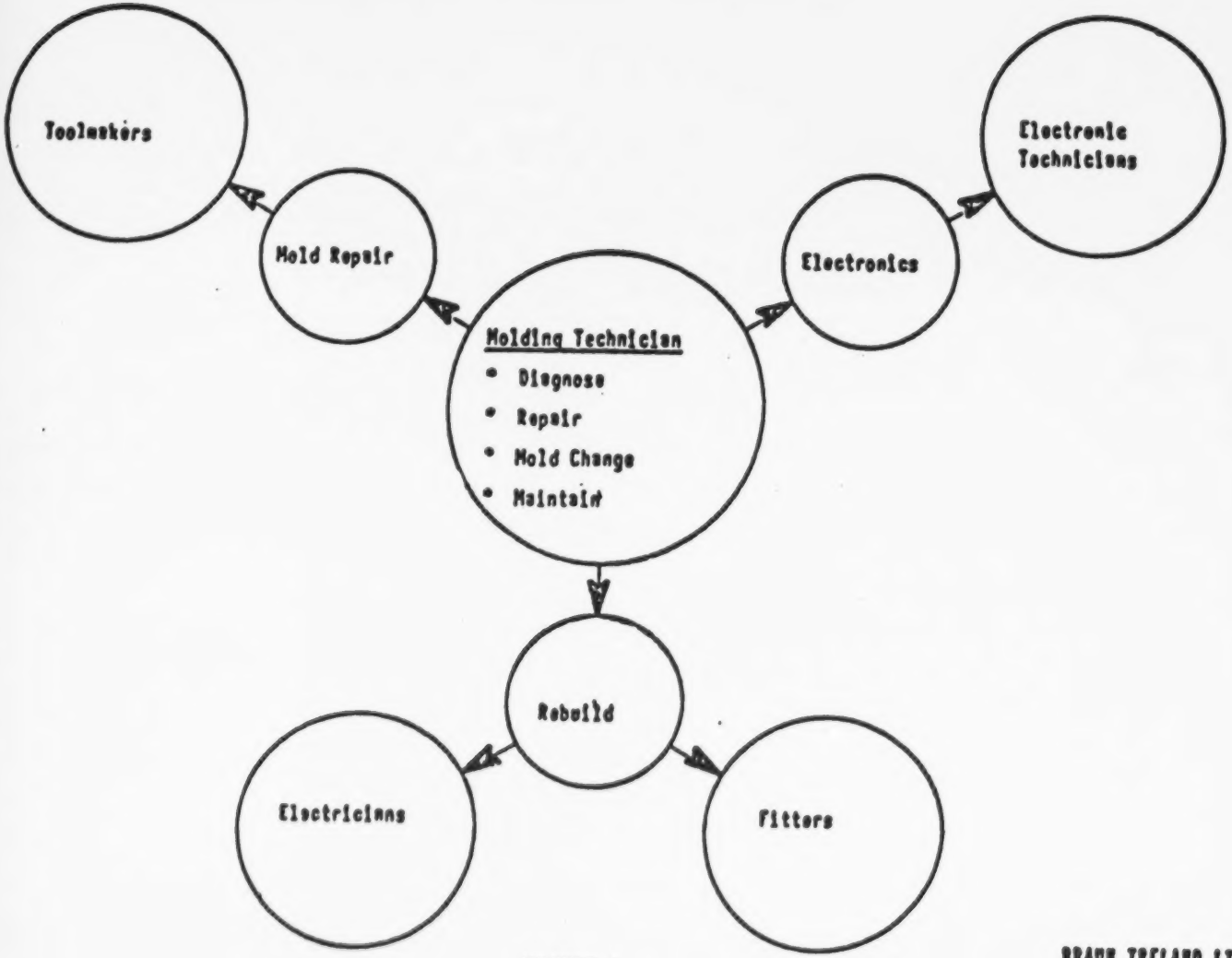


FIGURE 3

BRAUN IRELAND LIMITED

MANAGER TECHNICAL SUPPORT - ASSEMBLY

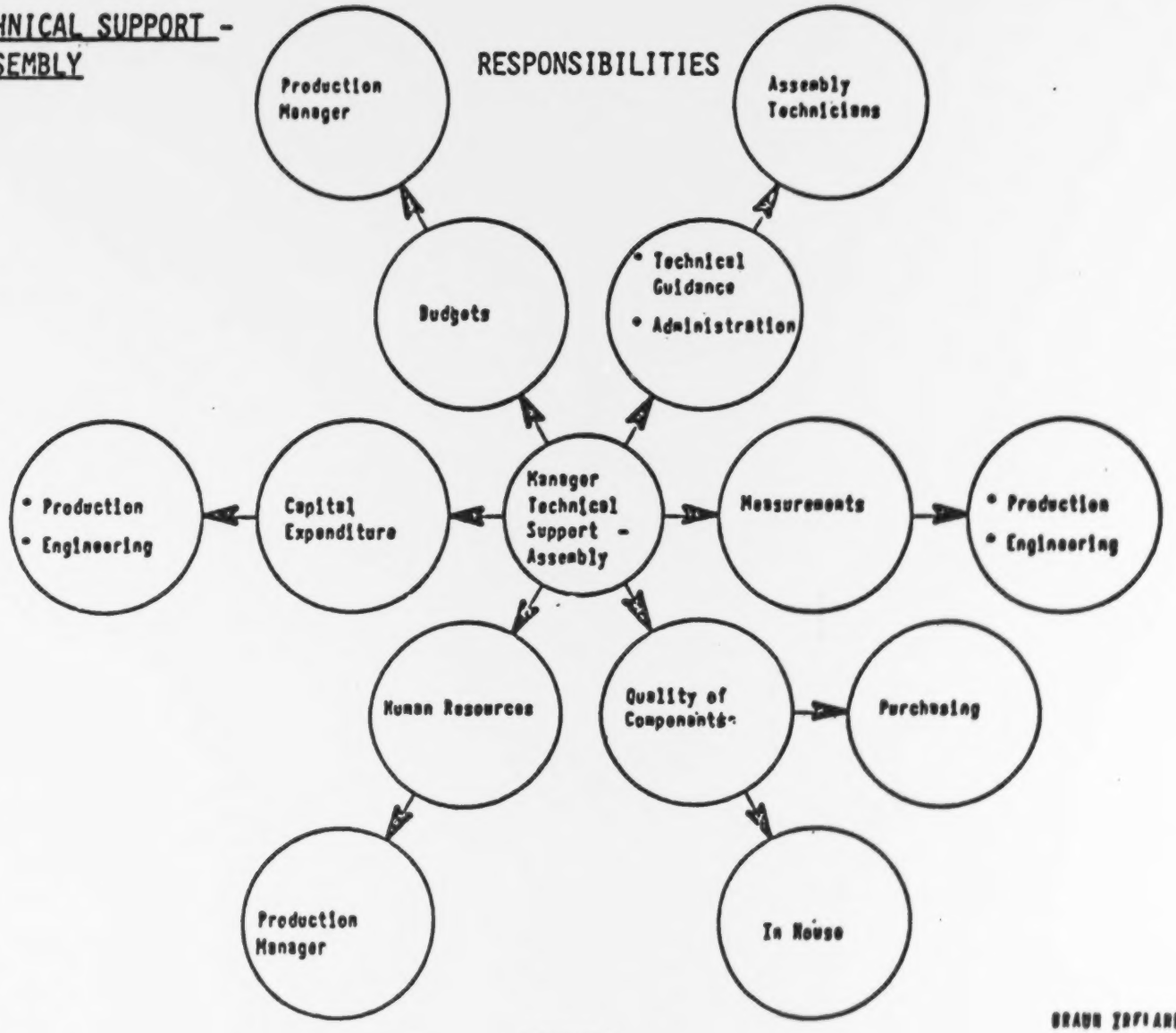


FIGURE 4

BRAUN INTIAND LIMITED

PROCESS CHART - MOULDING TECHNICIANS

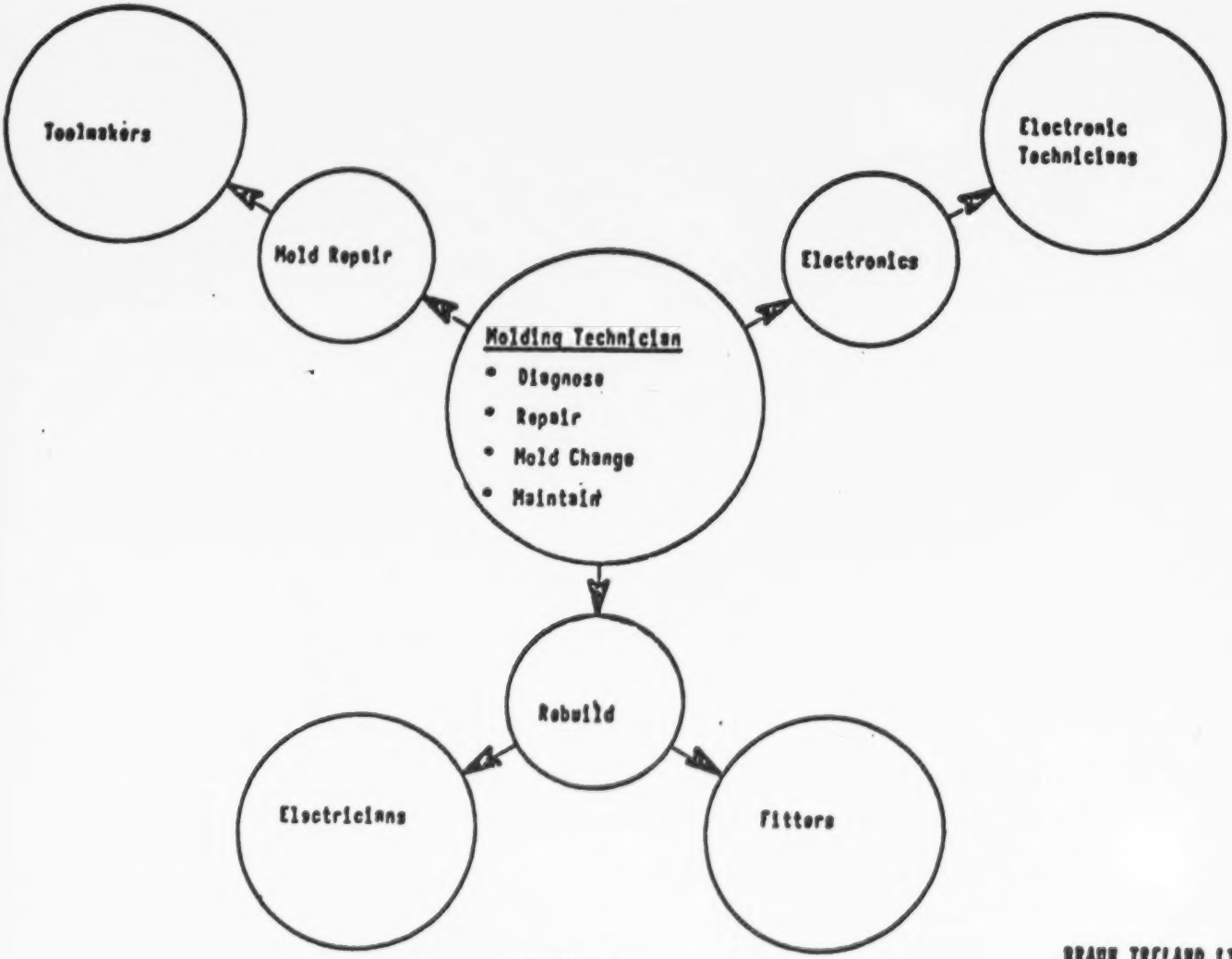


FIGURE 3

BRAUN IRELAND LIMITED

TRAINING PROGRAMME FOR TRAINEE MOULDING TECHNICIAN

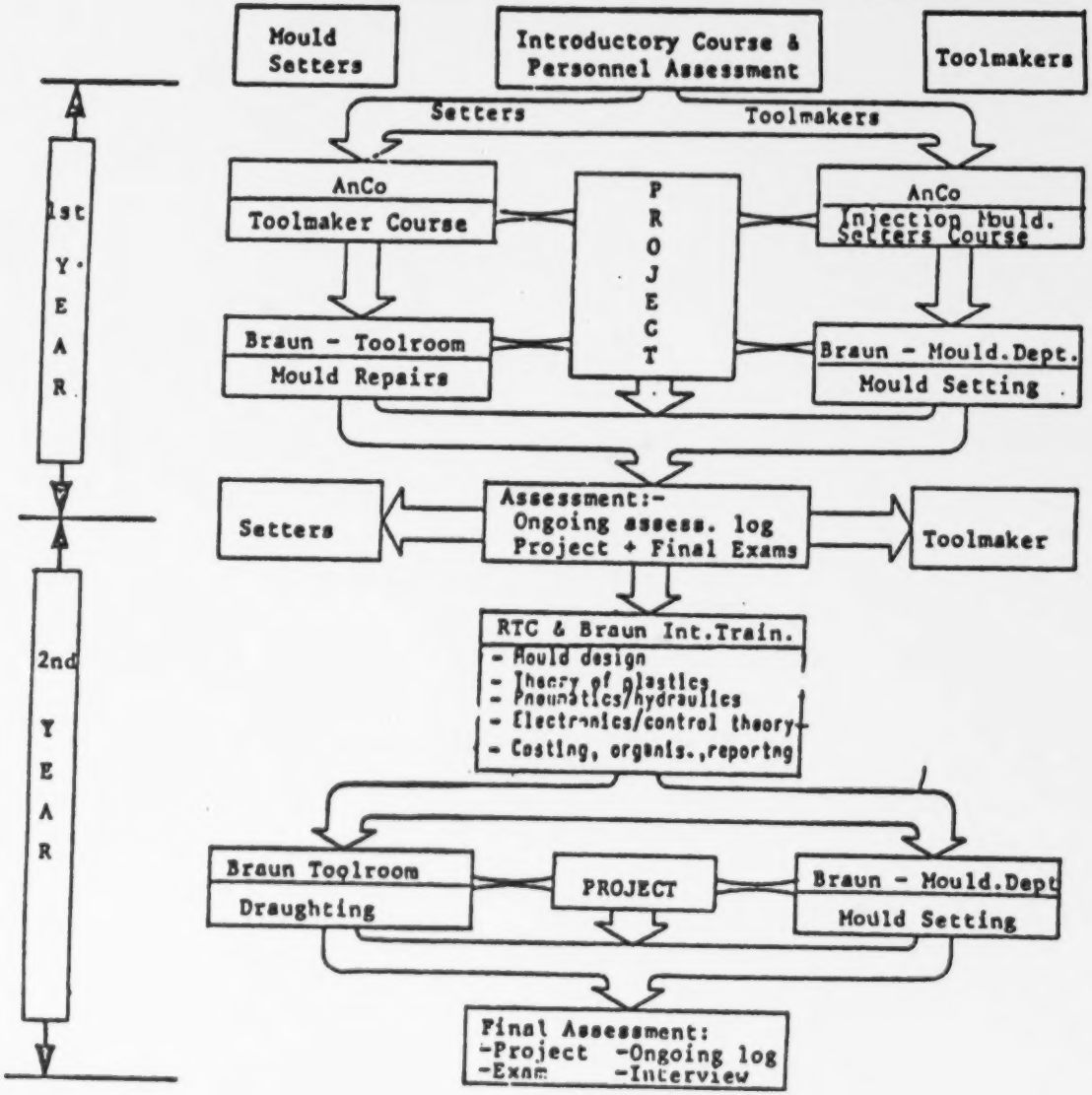


FIGURE 6